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ARE WE MAKING PROGRESS?*

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BY O. M. LELAND,

Dean of the College of Engineering and Architecture and the School of Chemistry, University of Minnesota; President of the Society.

In these days of strenuous living, when everyone magnifies the importance of his duties and obligations to the extent that there is little time in the twenty-four hour day for meditation, we are not likely to take time to interrupt the hectic course of our way and climb a mountain, as it were, from which to view the broad field of our operations and ascertain whether we are actually moving forward in the direction we wish to travel, or are merely traveling with regard to the objects immediately surrounding us. We may be hurrying along as the squirrel in his revolving cage, without getting anywhere. Our circle of travel may be quite large, so that we cover a great deal of ground, and still we may double upon our course and actually find ourselves in more than one respect, if not at our starting point, at least at some point previously passed. It is possible that in our continuous efforts to advance and improve, we may find ourselves at times headed in the wrong direction, so that we have to retrace our steps temporarily and make fresh starts to avoid obstacles and pitfalls which our experience has revealed.

In order to determine whether we are making progress towards our objectives, we must have a fairly clear idea of what these objectives are. All would agree that we are trying to provide the best educational preparation for the practice of the professions represented by our curricula, as well as those allied fields into which our graduates logically enter as a result of their education and training.

* Presidential Address delivered at the thirty-fifth annual meeting of the Society for the Promotion of Engineering Education at Orono, Maine, June 29, 1927.

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The work of our engineering schools may be divided into three parts; namely, the teaching of students, the increase of knowledge, and giving information to the public,—in other words, instruction, research, and service. The first of these, however, that is, instruction, is our primary function, to which we devote the greater share of our attention.

Even in this single branch of our field it is not always easy to define our purpose, although we have a general idea of it. We may say that the object of an engineering education is to develop in the student: first, a knowledge of fundamental facts, principles, methods, and practice concerned in his particular profession as a basis for his development through experience and study into a capable member of that profession; second, a certain amount of ability and skill in the elementary processes to enable him to earn his salary in a subordinate position upon graduation; and third, a basic foundation of character, habits, behavior, and general knowledge, sometimes called culture, to assist him in taking his proper place in society.

In the attainment of these objectives, there are many elements concerned which are involved in the progress made or the improvement produced. Among these are the students themselves, the curriculum, the instruction methods and facilities, and especially the teachers. I wish to consider briefly a few questions relating to the present conditions as compared with those of twenty or thirty years ago, perhaps, when many of us were students in our engineering courses.

One of the most important advances in modern education lies in the development of systems of measurement and their application to various phases and products of the educational process. Although they have resulted largely from studies in elementary or secondary schools, they are being used more and more in advanced work. The principles involved may be utilized in determining whether or not progress has been made. In fact, this is the real object of the measurement methods, that is, to determine the degree of success or accomplishment which attends our efforts. While these procedures

are far from perfect, they afford evidence of definite progress in the quantitative determination of the results of educational work.

It remains to be seen whether or not the methods of measurement, when applied to some of the more intangible qualities, especially in human beings, will prove adequate and dependable. The use of student grades as a basis of measurement is very common among certain investigators who, almost at the same time, decry the use of grades for marking scholastic work or achievement as unsound merely because all teachers of the same subject or different subjects do not use the identical standards for determining their grades. Also, as would naturally be expected, the methods may be misapplied or wrongly used, with results which are misleading and sometimes harmful. Common sense and judgment are necessary here, as elsewhere. We continually hear, for example, of teachers who determine the grades of students in a class, no matter how small, by the so-called normal frequency curve, or Gaussian curve of probability, without regard to the violation of basic laws or the existence of constant tendencies which would invalidate this principle of distribution.

Another feature of this measurement and testing process which is reaching many of us is the possibility of its being carried to extremes and made the objective of education, rather than its handmaid. It seems to be quite easy for a teacher to become so absorbed in the mechanism of measurement and tests as to lose sight of the importance of teaching his students. Moreover, the ramifications of statistical studies dealing with educational measurement may become the popular diversion of an entire institution. It would seem better in some cases that more adequate attention be given to the active instruction of students than to too detailed investigation of irregularities in scholarship among individuals. The variations in the mental qualities of human beings may not follow mathematical laws.

As we look for evidence of progress in the various phases of our work, let us consider the students themselves, to whose

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interests by far the greatest portion of our efforts are devoted. Do we see improvement in the student body and, if so, in what respects? Is their preparation for college better than it used to be? Is their college work as good nowadays as it was thirty years ago? Are they better prepared for their professional life upon graduation? These questions and many others of similar character are constantly before us. Opinions differ regarding all of them and depend, to a great extent, upon the viewpoint of the person expressing them. One thing must be borne in mind, namely, that the number of students in each institution has increased so remarkably during recent years, as to make comparisons difficult. In every respect, probably, we find among our present students more outstanding examples of ability than in the smaller groups of former days. On the other hand, it is a common opinion that on the average, the present student body is not so well prepared scholastically and less able and willing to devote itself to serious study. With the increased percentage of high school graduates going to college, it is inevitable that the average scholarship of college students should be lower. There seems to be a tendency among high schools the country over to pay less attention to intentive study and thorough preparation than to matters of popular interest and vocational development. In college, also, there is a greater demand than ever before upon the student's time by the so-called " outside activities " of various kinds. In many respects, these activities result in definite advantages to the students who participate in them, although it is easy for the student to neglect his studies on this account.

It is quite possible, therefore, that the young graduate of today is better prepared for a certain type of professional life than those of his father's time. More students seem able to speak in public without embarrassment and to take an active part in important movements, campaigns, committee work, etc., than those of years ago. In addition to this, the student today undoubtedly has a greater sense of responsibility and public service.

If, as a result of the larger numbers of students, there are more poorly prepared, mediocre college students, it does not follow that the results of the educational process are not better than they used to be. Of course, we like to see more high-grade scholars among our students,—those who would correspond to our best students at the present time. To produce this effect undoubtedly requires more intensive teaching, especially in the high school.

There is some question as to whether or not we are obtaining better students for our engineering schools. While less of them come from the practical work of the farm, a larger percentage have had the benefits of modern inventions, such as electrical appliances, the telephone, the radio, and the automobile, as well as manual training in the high school, to develop their knowledge of practical mechanics and the nomenclature of engineering. The automobile and motion pictures, especially, have contributed greatly to broaden the horizon of our youth.

The present tendency among high schools to place emphasis upon preparation for life instead of preparation for college seems to be weakening the average ability of high school students who continue their work in college. Engineering educators seem quite in accord with the idea that a return to the former type of high school preparation, in which all high school students pursued certain studies of acknowledged scholastic value, such as mathematics, history, foreign languages, and science, would result in better preparation for life with the high school as the finishing school, and very much better preparation for college. In the matter of preparation, therefore, there is a strong feeling that progress has not been so great as it should be.

For many years, there has been a gradual tendency away from the requirement of examinations for admission to college. It appears that where admission on certificate has flourished most, there has been the greatest percentage of increase in attendance. At present, more attention is being given to selective processes for admission, and the result may

be a diminution in college attendance and a raising of the average of scholarship, both in the high school and in the university.

With the increase in the numbers of students, the administration of our larger institutions has become correspondingly complex, and sometimes mechanical to an undesirable degree. Larger numbers of students are indifferent and careless about following directions and require special groups of advisers. The university gives more and more attention to student welfare, and becomes in this way paternal, notwithstanding its greater size.

In this connection, notable advancement has been made in the guidance of students in the selection of a profession in the engineering field. This is especially needful in view of the number of separate branches of this field. The idea that engineers are born, not made, is giving way to the principle that the student with ability and energy can succeed in almost any line of endeavor. It is important that the young man be provided with information of authentic character which he can use with his experience and fundamental knowledge as a basis for his decision. It is being recognized that the proper profession for a boy is that one in which he would most enjoy his work, and that the salary is of secondary rather than primary consideration. No longer is a student advised to take an engineering course because he has always liked to play with tools, or because he excelled in manual training in high school. Instead, his mathematical ability is likely to be a determining factor.

If there is one place in our system of engineering education in which definite progress has been made, it probably lies in the engineering curriculum. Without sacrificing the advantages of the prescribed courses of study, our curricula have been developed in accordance with the advances in the corresponding professions and the increasing emphasis given to broader preparation, for it must be borne in mind that the engineering course is a professional course, and not an academic or purely cultural one. It cannot be said, however, that

corresponding progress has been made in methods of instruction. Here, there is room for improvement, in all probability. Many didactic lectures are as inefficient and unsatisfactory as ever, and should be replaced by recitations and tests, using accurate text books or other printed material. In most engineering courses, daily tests may be given to advantage, with resulting stimulation to the students. With the added activities which tempt the student away from his studies, it is necessary that the teacher give special attention to methods of instruction which will compel the student to concentrate systematically upon his studies. Laboratory work has assumed increased importance as a method of instruction, and has been developed to a remarkable extent.

Important progress has been made in the recognition of the importance of suitable buildings and equipment as facilities for instruction. Buildings constructed at the present time for engineering instruction are more adequate and convenient. Equipment is very extensive and practical, and the young graduate may thus have better preparation for entrance into industry than ever before.

But of all the parts of the instructional organization, the engineering teacher holds the key position. What can we say regarding the teaching staff? Are they, as a class, better qualified than they formerly were? One thing must be admitted. They are specialists to a greater degree, and as a result, it is possible that they are more technical in their instruction and less inspiring to their students. For it is well known that the old-style engineering teacher was, in many respects, a patriarch, a father of his class, and a source of inspiration to them, so that he holds an important place in their memories. It is doubtful if the present-day teacher will make such a place for himself in the minds of his students, although there will be exceptional cases, of course.

In another respect, also, is the teacher of today likely to be criticized. This is in his lack of the recognition of his obligations to mould the characters of his students. The modern university teacher is apt to ignore or minimize the influence

which he can exert over his students, both in and outside of class. In many cases, the teacher does not understand and accept the responsibility which he has as a guide and example to his students in those traits of character which determine success and the respect of one's fellow men. For, after all, the development of character is the most important part of teaching, and the one for which the qualities of the individual teacher are most significant. From him, students get breadth of vision, culture, liberal views, and ethical standards. His methods of teaching cultivate habits in his students which will have a definite influence upon their entire lives.

Considerable progress has been made in the improvement of the salary situation among engineering and college teachers. The initial salary for the younger instructors seems sufficient to attract high-grade men, even in competition with industries. Moreover, the salaries of full professors are gradually reaching a satisfactory basis in our larger institutions. The middle class salaries of assistant and associate professors, however, are still below the figures necessary to hold these men against the industrial call. However, teachers must expect to partake of the character of public servants and must understand that money is only a part of their compensation, if they are to retain the position they should hold in the public estimation.

Progress is a relative thing and also a very complex one. Everyone wishes to be considered progressive, rather than reactionary. No teacher worthy of the name is willing to admit that he is not interested in the improvement of his work, his methods, or his material for the benefit of his students. Consequently, we are making progress of some sort in most branches of our work. We are trying and hoping for success in every part of our field. Perhaps the greatest evidence of this in the work of this Society lies in the great investigation which has been its principal activity for the past four years.

While we desire to advance and improve, we must not be so eager as to lose sight of the well established principles which have been developed through our years of experience. We must keep our feet on the ground and our heads up, and not

be carried away by false theories. Although progressive, essentially, we must be conservative, for the success of engineering education depends upon the respect and confidence of the great body of a profession which is based on fact and not opinion, and on safety and certainty, rather than on conjecture.

A CHALLENGE

R. L. SACKETT,

President of the Society.

Two years ago this Society voted to approve and undertake an investigation of engineering education in the United States and Canada. This was a memorable and momentous step which impressed the Carnegie Corporation with the possible contribution which such a survey might make to education in general, but especially to technical training.

Through the energy of the Board of Investigation and Coordination and the sympathy of President Keppel, funds were provided; a Director was obtained, Dr. Wickenden and an assistant, Professor Hammond.

Through the admirable cooperation of many committees in over 40 institutions of representative character, a large volume of facts was obtained, tabulated and interpreted to the Society. The latter owes much of the success of this undertaking to the excellent spirit with which the various committees worked under the leadership of the directing committee.

This phase is history. The ground has been thoroughly cultivated. The seed has been sown. Neither the coordinating committee nor the directors of the investigation can gather the harvest, thresh it out and market the grain.

The final valuation of this investigation will be made by the individual members and the institutions with which they are connected.

Interest has been at concert pitch through the directive efforts of those in charge of the survey. The solo parts have been rendered; will the chorus—the Society—accept the challenge and carry on the theme with judgment, harmony, and balance? Does the Society—each member—realize that he has a part written for him and is he going to accept the score and carry it to its completion? It will not measure up to its theme if it does not influence American engineering education in a sane but positive manner.

A BRIEF REPORT AND IMPRESSIONS OF THE SUMMER SCHOOL FOR ENGINEERING TEACHERS AT CORNELL UNIVERSITY AND UNIVERSITY OF WISCONSIN.

BY H. P. HAMMOND,

Associate Director of Investigation.

It is too soon immediately after the completion of the first sessions of the Society's Summer School to give a detached or exhaustive appraisal of its results. This report will therefore be in the nature of brief comments, supplemented by excerpts from some of the statements received from those who attended. A much more detailed report will be published when the complete records of proceedings have been compiled and edited.

The general impression of those who attended or observed the schools seems to be that the work may be pronounced successful; in fact no opinion to the contrary is to be found among the numerous comments which have reached the Director's office. Recognizing that the undertaking was inevitably more or less experimental for the first year, with almost no precedents to serve as guides in planning it, the unanimous conclusion seems to be that the results were all that could have been hoped for or expected. All agree that the work should certainly be continued. In one important respect the experimental first year served its purpose admirably; that of pointing the way to improvement through the strengthening of some features and the reduction or elimination of others. In the writer's opinion, the general purpose of the conferences; namely the study and discussion of methods of teaching particular subjects of the curriculum, was rightly conceived. All correspondents agree that the portions of the program which served that purpose most directly were the most valuable. The general desire seems to be that even more emphasis be placed on the discussion of classroom methods. It is difficult to evaluate the various factors which contributed

most largely to the success of the undertaking and no attempt will be made to do so here. One factor, however, which is not likely to be found in the comments of those who attended will be mentioned; namely the character of the groups of teachers comprising the conferences. Whatever the nature of the formal work of the sessions, the assembling of such fine groups, the unusual opportunities for informal discussions and exchange of ideas, the formation of friendships and acquaintanceships, and the social diversions which were made possible through three weeks of close association in pleasant surroundings were worth all the expenditure of time and effort. Of no less importance was the admirable work done by members of the staffs both in and outside of the formal sessions, for which too much cannot be said.

The programs of both the Cornell and the Wisconsin sessions were carried out in rather close accordance with the outline published in the May, 1927, number of the JOURNAL. At both schools the opening day was devoted to registration, appointment of committees, and addresses by the directors and members of the staffs. Smokers were tendered by the local faculties to the members of the conferences on the evenings of the opening days. These smokers were very enjoyable and afforded opportunity for the members to become acquainted with each other and with the members of the staff and the local faculty. They promoted a spirit of intimacy and good fellowship which was one of the most striking features of the sessions. Regular work was begun on the second day with lectures and discussions of fundamentals in mechanics and objectives in teaching the subject. These were followed by discussions and expositions by members of the staffs and members of the groups on the teaching of particular sections of mechanics and on the history of the development of the science of mechanics, and by meetings devoted to seminars, model teaching, assigned exercises, preparation of reports by committees, laboratory demonstrations and the other items of the programs. Special lectures by authorities in the several fields of engineering in which mechanics is most frequently

applied were given in the course of the sessions. Meetings were also held in the laboratories of materials testing and physics in which demonstrations were given of the conduct of tests illustrating methods of teaching or the applications of the principles of mechanics. At both sessions the Educational Advisers presented formal lectures, participated in the discussions, and advised with other members of the staffs on matters concerning the conduct of the work.

An important part of the work at Wisconsin was the preparation of reports by committees on a number of topics; including, Correlation of Mechanics with Other Engineering Subjects, Minimum Essentials in Analytic Mechanics, Class Room Methods, Written Tests, Home Problem Work, Apparatus for Teaching Analytic Mechanics, Organization and Administration of Courses in Analytic Mechanics, Objectives in Teaching Analytic Mechanics and other similar topics. An interesting feature of the Cornell program was that devoted to presentation by members of the local faculty of their methods of teaching mechanics in accordance with the principles established by Professor Irving P. Church. An item of the Wisconsin session which proved of special value and interest was the presentation by Professor Curtis Merriman of the results of a study of methods of teaching mechanics employed in a considerable number of institutions throughout the Middle West and adjacent southern states. This study also included the reactions of students to a number of questions relating to the methods employed in presenting the subject to them and their opinions thereon. It was interesting, among other points, to learn that the students of the five institutions canvassed for such opinions (Illinois, University of Iowa, Minnesota, Purdue and Wisconsin) believe that the instruction in mechanics is, in general, excellent and that they rate the teachers of mechanics high in comparison with the faculties as a whole.

Throughout the course of the conferences a number of very pleasant recreational features were provided. At Cornell there were beach picnics, tramps, automobile trips to Watkins

Glen, Taughannock Falls and other places, and a tennis tournament. A special feature of the Wisconsin session was a trip by automobile to Devil's Lake and the Dells of Wisconsin. Most of the members at Madison also took advantage of the other numerous opportunities for pleasant recreation afforded by the city and Lake Mendota. At Cornell a subscription dinner at which Professor Irving P. Church was the guest of honor was held at the end of the session. The dinner was attended by the forty-odd members of the conference and staff, a considerable number of the Cornell faculty and by President Farrand of Cornell and Past-President Leland of the Society. Professor W. J. Risley of the Colorado School of Mines presided. The dinner appears to have been a most enjoyable affair. Some of the features were original songs and highly entertaining poems written by members of the group and staff.

With one or two exceptions all of the members of the conferences and the full-time staff were housed together; in Boldt Hall at Cornell and in Tripp Hall at Wisconsin. All of the members testify to the value of the associations formed through this arrangement and speak of the benefits derived from the informal conferences and the opportunities to talk shop after the days' sessions. In a visit to these residence halls in the evenings one would overhear the liveliest sort of discussion of the day's proceedings and occasionally a heated argument. These informal gatherings gave the younger men in particular opportunities to engage in discussions and to state their views on matters related to the content and methods of teaching their subjects.

Seven of the evenings at each session were devoted to special lectures by individuals other than the members of the staffs. At Cornell the speakers were L. W. Wallace, Executive Secretary of American Engineering Council, John Parker, Vice-President of the Brooklyn Edison Company, Charles F. Scott, Chairman of the Board of Investigation and Coordination, W. E. Wickenden, Director of Investigation, Parke R. Kolbe, President of the Polytechnic Institute of Brooklyn, and R. E. Doherty, Consulting Engineering with the General Elec-

tric Company. Professor Karapetoff of the Cornell Faculty also gave a concert on cello and piano. At Wisconsin the speakers were President Glenn Frank, C. S. Slichter, Dean of the Graduate School, H. L. Russell, Dean of the College of Agriculture, W. E. Wickenden, H. F. Moore of the University of Illinois, C. K. Leith, Professor of Geology of the University of Wisconsin, and A. N. Talbot of the University of Illinois.

The organization of staff and members of the conference were essentially the same at the two sessions. At Cornell, for example, the director, secretary, educational adviser and the three members of the staff who regularly teach mechanics formed a steering committee. This committee met daily to discuss matters relating to the conduct of the work, arrangement for subsequent days, and similar details. At each session there was also an advisory committee of members of the conference which met and cooperated with the steering committee two or more times each week. The joint committees considered matters relating to the program, methods of conducting the sessions, questions raised by members and other matters. A number of modifications of the programs were made as a result of these meetings. Question boxes were provided which were used by members who desired to have certain matters discussed in the sessions or who wished to submit suggestions as to features of the program. Committees on recreation dealt with matters relating to that feature of the programs.

A total of eighty-two teachers were enrolled in the two sessions; forty-one at each. In addition a few others attended irregularly as auditors. Sixty-four institutions located in all parts of the country from Maine to California and from Minnesota to Texas were represented. The groups included teachers of all ranks and of a great range of teaching experience. At the two sessions there were fifteen professors, ten associate professors, twenty-eight assistant professors, twenty-seven instructors and two of other ranks. The expenses of just about half of the teachers were paid in full or in part by

their institutions. The others attended entirely at their own expense. The teaching staffs comprised twenty-three members, as listed in the May, 1927, number of the JOURNAL, except that Professor G. M. Works of the Cornell staff was obliged to resign due to a change in his position, his place being taken by Professor R. M. Stewart of the Department of Rural Education of Cornell University.

As stated above the writer does not feel inclined to give anything of his personal impressions of the value of the work and will do so only through the statements of those who attended. One indication of the feeling of the members of the groups is given by the fact that permanent organizations of the members were formed on their own initiative. Committees, each having a secretary, were organized to act for the groups until the next sessions devoted to the teaching of mechanics are held. These committees are intended to form a nucleus of teachers interested in the problems of teaching mechanics, to keep the members in touch with one another and to cooperate with the Society's standing committee on mechanics. At the conclusions of the sessions the following resolutions were passed by those attending:

RESOLUTIONS

CORNELL SESSION

The Members of the Cornell Conference on the Teaching of Mechanics herewith adopt the following:

To the Officers of the Society for the Promotion of Engineering Education, who conceived and made possible this Conference, we express our keen appreciation of the opportunity that has been afforded us to participate in this valuable project; and to the Carnegie Corporation of New York, we express our appreciation for the generous contribution of funds which was essential to the successful consummation of the plan.

We offer our hearty thanks to President Farrand, Dean Kimball, Professor Walker, and the members of the Faculty and Administration of Cornell University, who have spared no pains in providing for our comfort and have most happily combined a program of recreation with a schedule of work.

And we acknowledge our deep obligation to the special lecturers and to the Director and members of the Staff of the Conference who have so ably arranged and presented the program.

We believe that the Conference has been of very real value and that its effects will be reflected in improved methods of teaching and in better balanced courses.

Wisconsin Session

Realizing the impossibility of adequately thanking those responsible for the success of this, the first Summer Conference for Engineering Teachers, yet being desirous of expressing the sentiment of those fortunate enough to be in attendance here; therefore be it resolved that we take this means of showing our appreciation:

(a) To the Society for the Promotion of Engineering Education whose staff of Investigation and Advisory Committee on Summer School first sponsored the undertaking and then formulated the plans for this inspiring meeting;

(b) To the Carnegie Corporation of New York, whose generous appropriation has made this conference possible;

(c) To the University of Wisconsin, which has acted as a kindly Alma Mater during our brief but pleasant sojourn here;

(d) To the College of Mechanics and Engineering of the University of Wisconsin, which has, both as a group and as individuals, been our most gracious host;

(e) To that group of loyal workers known as the "Steering Committee" composed of Professors E. R. Maurer, A. P. Poorman, and S. M. Woodward, who, by their own initiative, their counsel, their experience, their forethought and good will, have contributed so largely to the benefits that we have gained;

(f) To Mr. L. F. Van Hagan we are especially indebted for the successful carrying out of the duties of Secretary of the Conference, and for the time and effort that he has so generously and graciously given in our behalf;

(g) To President Frank of the University and to the members of the University Staff who have brought before us in Special Lectures, in Laboratory Demonstrations and in Critical Discussions a better understanding of the intimate relationships that exist between all the lines of scientific endeavor;

(h) To those who have come to us from special fields of teaching and of experience to show us the applications of our work in these special fields and to point out ways of practical improvement.

Respectfully Submitted by the
Committee on Resolutions:
LeRoy Tucker, *Chairman*,
M. K. Snyder,
J. H. Robert.

July 28, 1927.

Aside from the values derived from the associations, the informal contacts and the recreational features of the program, the members testify to the solid and substantial benefits derived from the undertaking. The comments which are printed below are selected so as to give a representative sampling of those received in response to a request for the submission of critical statements analyzing the various features of the work.

In making this request it was particularly requested that the comments indicate ways in which the work may be improved, either in general principles or in details of conducting the work. Matters which are in the nature of discussion of minor points have been purposely omitted from the portions quoted below.

COMMENTS BY MEMBERS OF THE STAFF

"In accordance with your request, I am writing you my impressions in regard to the success of the S. P. E. E. Summer Session on Mechanics. My opinion may be biased, but if I can judge of the results by the comments of the members at various times, the school was eminently worth while. I feel that all of the expenditure of time, labor and money has been amply justified. Almost without exception the men were enthusiastically interested in every session from beginning to end. Those who were compelled to leave early expressed great regret at losing a part of the work, but said they were expecting to receive a full account of the remaining sessions in the JOURNAL.

"The committees worked industriously, and, with one exception, harmoniously. The various methods of accomplishing our fundamental purpose of teaching mechanics were compared as to results with a candor and open mindedness truly remarkable. As might be expected, opinions sometimes differed, and in several cases committee reports were amended by the conference before being adopted. We trust that these reports will be received by our fellow teachers in the same spirit in which they are presented, not as dogmatic statements, but as the present best judgment of this group.

"The chief complaints were that the schedule was so full that there was only slight opportunity for taking advantage of the many chances for summer sport here. Almost without exception, however, the men said they were here for the purpose of getting the greatest good out of the conference, and their complaints were not intended seriously.

A number expressed the hope that something more permanent than had yet been contemplated might grow out of the conference. Various plans were discussed, but nothing very definite was formulated. The ideas embodied in the resolution adopted may be impossible of execution, but are to a certain extent a measure of the interest of the members in the session just closed. I hope that next year's session, if one is held, may be as successful as ours has been."

"Having been on the staff of the Conference for Teachers of Engineering Mechanics for about a week I take the liberty of putting on paper my impressions of that conference.

"The first impression, and the outstanding impression I received was that of mental curiosity and of eagerness. The teachers came, usually at some personal sacrifice and they were determined to get some return from their efforts. I never worked at more inspiring conferences.

"It seems to me that much of direct value in technical knowledge and ideas must have been gained by the men at the conference. There was a very free and vigorous exchange of ideas, and different sides of many problems were presented. There was no small amount of disagreement, but no dispute.

"I think Professor Merriman's contact with the group was very helpful. His open frank manner encouraged questions and discussion, and the presentation of the viewpoint of the professional educator was of great suggestive value.

"I think the conference was about the right size. There were enough men there for inspiration, and not enough to make discussion difficult. I think that a somewhat smaller room would be a good idea for any future conferences.

"Perhaps I may sum up my impressions by characterizing the conference as the auspicious beginning of what it is hoped and expected will be an important and unique department of the work of the S. P. E. E."

COMMENTS BY MEMBERS OF THE CONFERENCE

"In trying to appraise the value of the conference of mechanics teachers now coming to a close, I find very little with which to find fault and much to approve.

"I believe that I have got enough definite suggestions of methods whereby my teaching can be improved to make the time well spent, and any improvement that I can make in my teaching directly benefits the institution in which I teach.

"The general plan of the conference, was, in my opinion, well thought out and well arranged.

"The lectures from which I got the most profit were those that went somewhat over my head. The result was to increase my determination to keep up my work in new topics and to increase the distance between my knowledge of the subject and what I try to give the student.

"In some of the more elementary work I think better results might have been secured with somewhat less attention to details.

"The outside lectures of a technical nature I found most interesting and stimulating. Those of a general nature were of less direct benefit to me.

"I believe that the conference would have been somewhat more successful if it had been made up of teachers of mechanics only. While I have no doubt that instructors in other subjects profited somewhat from the discussions, they were able to contribute very little to the success of the conference."

"The place, the group, the staff and the director have been wisely chosen and have left little to be desired.

"The general plan and purposes of the conference have been splendidly conceived and carried out. The steering committee, made up of the director, secretary, staff and so-called program committee has been the pulse, as it were, to keep in touch with the situation as a whole, to feel out the reactions of the laity of the group, partially to direct suitable channels of thought among the group and to re-

flect the convictions of the group toward the detailed conduct of the conference.

"The stimulating effects of the unofficial sessions, the so-called bull sessions, at which men speak their minds freely and with less reserve than they do in the formal sessions—these have contributed much toward the solid successes of the conference. As a fairly active participant in a considerable percentage of these extra-curricular activities, I have watched with delight the development of that type of solidarity which augments the successes of any undertaking. . . . To cement a group, gathered as this group has been, into a fairly unified unit, yet with each member retaining his own individuality of thought and opinion, and to get all this effectively at work during almost the entire period of the conference, that has been an accomplishment of no mean order; it has been vital to the success of the conference. May I testify to the solid influence of half a dozen young chaps in the group who have contributed measurably to this? The atmosphere of assured success has been keened up to no small extent by the spirit generated among them.

"I should say that there have been developed suitable varieties of mental and spiritual hungerings among the group, that ideals of the size of the job and of its responsibilities have been both formed and developed, that keener senses of their opportunities for enduring investments in influence on the active lives of young men have been developed and solidified, that their growing pains of real teaching manhood have been active throughout the session and, with suitable mixture, are likely to persist to their betterment."

"In order to make clearer my reaction to the summer school I shall briefly describe my position in teaching work. Next September I shall begin my first classroom instruction. My two years of previous experience have been entirely in the laboratory with informal instruction and no lectures.

"I am entirely sure that because of my attendance at the summer school I shall begin my work next year with much more confidence and with a greater chance of success. The benefits of the session are intangible and it is difficult to describe them explicitly. There is a certain inspiration in hearing at first hand the instruction of eminent teachers and engineers, in addition to the immediately usable methods in handling specific classroom problems, which come both from the experienced men and from the younger members of the conference who have more recently faced my own problem of beginning work in the right way.

"The close association in Boldt Hall of the members of the conference makes it possible for even the youngest members of the group, who have little to say in the formal meetings, to enter into the discussions of teaching which are carried on there each evening. The importance of the trips and picnics, and the banquet should not be overlooked in future conferences. They mean better acquaintance and a unifying of the group which could be achieved in no better way."

"The purpose of the school has been the development of improved methods of teaching basic subjects of the engineering curriculum. I would like to go a step further in stating the purpose of the en-

terprise, namely, that its purpose is also 'to instruct and to inspire.' These two words sum up the effects of the school on me. I have been instructed in many principles of teaching and teaching methods and I have been inspired to make my teaching mean more to my students than it has in the past, I have gotten a much larger conception of engineering and what engineering means and what it has done for civilization, and of engineers themselves.

"Has the aim of the enterprise been rightly conceived? I firmly believe so. We have heard and know it to be a fact that teachers, many of us at least, are prone to become 'stale.' . . . I can think of no better way to arouse and revive the old interest and to place before us the timely subjects and developments in engineering teaching and education."

"I have most certainly been helped personally. By comparing notes with the staff and with the other members, in formal and informal conference, I have been able to analyze my own teaching in ways not suspected before, confirming certain practices as sound and of use by other successful institutions, and showing the weakness or futility of certain other features, all of which had been derived from experiment. It was the first time that I had had a chance to compare in such a frank manner.

"It confirmed a feeling that a young instructor must go back and practically re-do his mathematics, as well as take more than he probably had as an undergraduate, chiefly because most of us had no intention of teaching, and were probably not the 'brightest' men in those classes. Likewise physics. It also showed clearly that if we ourselves could not really grasp those preparatory subjects, we could hardly expect the average student to have mastered them, and that we must be prepared to help them out more sympathetically as well as study and suggest ways to improve the teaching of such fundamentals.

"It is clear that I must study Mechanics much more intensively, both the portion which is to be taught, and parts of advanced mechanics which will give a better perspective of the whole field. Likewise, I must give more attention to coordinating the Mechanics and Mechanics of Materials with courses in other departments which follow them.

"The fundamental idea of the conference was to study teaching methods, and I believe that to be the correct object. In fact, my only suggestion is that it might have been well to omit a few of the more complex subjects discussed in favor of replacing them with more 'testimonial' talks by the older or more experienced members of the conference. My own personal notes include mostly specific details of how so-and-so did this, or that he did not try to do this, etc., points which I shall mull over in making up schedules and planning definite attacks on troublesome parts of the courses.

"In general, the course seems very well balanced, with not too much of one feature, nor much of it at one sitting. The recreational features and the living all together under one roof have been exceptionally happy experiences, in that we could get a more human and intimate slant on our colleagues, and so judge more intelligently their expressed opinions. It was a distinct surprise to find out how much shop was talked in leisure moments. It would have been practically impossible properly to evaluate these ideas without this

chance to live together. The recreation periods insured that we had enough exercise to keep in condition, and prevented our minds from going stale on too much schoolwork.

"I have no suggestions for a next year's course, except that I hope it may be possible for me to attend it!"

"As the youngest and perhaps the most inexperienced teacher at the conference I find it difficult to write a report that may be of value to the Society for the Promotion of Engineering Education.

"The Summer School for Engineering Teachers has been a source of much information and inspiration and the association with men of high standing in the profession is invaluable. I feel that it has been a privilege to have been a member of this conference."

"In reporting on my attendance at the conference of teachers of engineering mechanics I wish to divide my remarks into two general heads.

"First as to benefits personally derived. I was most interested in presentation of methods of teaching the subject in general together with matters of organization. The stimulus of the conference in general and of some of the speakers in particular made, in my opinion, the attendance at the conference decidedly worth while.

"Secondly I suggest as possible changes for a future conference, more emphasis upon teaching methods as presented by teachers of the subject; less use of model presentation of subject matter especially quasi-model presentations where there is no class. Probably with such changes the session could be shortened to two weeks.

"The institution which I represent, . . . paid my expenses and I think are going to get their money's worth. Personally I feel that my time has been well spent and that I have at least to some extent been lifted out of a rut."

"I, for one, wish to express my appreciation for the opportunity the S. P. E. E. has given me to attend this school. And, if I make any adverse criticism, I do so because of your request to benefit the organizers of future conferences.

"I have been sent by the . . . to attend this conference. I have been a close observer of all the proceedings, got new ideas and helps on the teaching of mechanics, and obtained a better perspective of the engineering curriculum. I hope to attain even more efficiency in my class-room work because of definite standards which I have formed, based on the very practical reports made out by various committees, and by the practical remarks which I took note of as one session followed another.

"I think, however, the sessions were too long. One and a half hour sessions in the morning and afternoon, followed by group committee meetings, would have been sufficient. In the group meetings which in the earlier part of the conference followed each talk, there seemed to be more freedom of discussion than later when the entire assembly took part in the discussion.

"Bringing Professor Merriman in as educational adviser was capital. Now, I know from the bulletins issued by the S. P. E. E. that wonderful work is being done which would interest the engi-

neering teacher. Why could not some one have brought to the men in the conference, a summary of this work? I do not consider this propaganda but a means of stimulating interest in a field that we are all interested in. I know that such a summary would not have touched on mechanics, but I believe there are other interests closely associated with our teaching tasks, that ought to be of interest to us all. I make this suggestion, because, besides myself, there are others who did not belong to the S. P. E. E."

"On the eve of the breakup of the conference I wish to express my gratitude for and appreciation of the opportunity afforded me by you and your committee through this conference.

"My classes will benefit in that for a few years at least I will more closely watch my teaching both as to matter and manner. I now realize some of my faults that were of such long standing that I did not recognize them as faults.

"Personally I have gained through the creation of a group consciousness, that makes me feel my work more worth while and that stimulates me to greater study and endeavor.

"Though I paid all of my expenses amounting to over $250 if next year's conference related to subjects I knew I would like to attend.

"My suggestions for change are minor—

"I believe that the so-called 'model presentations' should be more truly sample lessons. They were more presentations of subject matter than demonstrations of method. This is not true of all cases.

"I believe the session was too long. The group became restless before the three weeks were up.

"Many have said that the work was too strenuous at first. I do not agree. I believe that the swift pace of the first few days drew the bunch together, speeded up their gait, and gave a chance for wants to accumulate so that when the pace was slackened we had something to do and did not sit about complaining. Such pace must not be kept up long but I believe it was wise at first.

"I believe that the term summer school should not be used. The term conference is more dignified and would enable more teachers to get their expenses paid. This was more truly a conference than a summer school."

COMMENT BY A SPECIAL LECTURER

"I was impressed by the enthusiasm of the members of the group, and heard nothing but most favorable comments regarding the efficacy of the sessions. I think you are to be congratulated both for the courage to put the thing across, and upon the apparent success of the undertaking."

One statement which occurs in almost all of the letters is that the enterprise has proved its value and that it should be continued in subsequent years. It is hoped that the financial

problem of continuing the work may be solved. In the meantime, it is also hoped that all members of the Society who have any suggestions to offer regarding the next and subsequent sessions will submit them to the writer. It is particularly hoped that some indication will be given of the desire to devote sessions of the school—or conference—to particular subjects of the curriculum. If a sufficiently clear-cut expression of opinion favoring a particular subject or division of the curriculum is obtained a session or sessions of the work may be devoted to it.

Complete records of the proceedings of the 1927 sessions were kept by the secretaries of the two staffs; Professors Walker and Van Hagan, assisted by members of the conferences acting as reporters of the several meetings. These records are now being studied and edited and it is hoped to publish them in the near future so that they may be available in rather complete form to all of the members of the Society.

Left to Right.

Upper Row.

A. Fick, Marquette University, Instructor in Civil Engineering
S. B. Folk, Ohio State University, Asst. Prof. of Mechanics
P. T. Norton, Jr., University of Wisconsin, Instructor in Mechanics
M. O. Withey, University of Wisconsin, Prof. of Mechanics, Staff Member
H. L. Turritin, University of Wisconsin, Instructor in Mechanics
Edward Bennett, University of Wisconsin, Prof. of Electrical Engineering, Staff Member
F. C. Hartwich, University of Dayton, Prof. of Mechanical Engineering
Banks McLaurin, University of Texas, Instructor in Civil Engineering
K. F. Wendt, University of Wisconsin, Instructor in Mechanics
A. S. Hansen, Armour Institute of Technology, Instructor in Mathematics

Row No. 2 from Top.

J. C. McKinnon, Alabama Polytechnic Institute, Instructor in Mechanical Engineering
G. P. Stocker, University of Arkansas, Prof. of Civil Engineering
F. H. Wade, Lewis Institute, Asst. Prof. of Mechanics and Physics
H. E. Pulver, University of Wisconsin, Extension Division, Assoc. Prof. of Civil and Structural Engineering
A. P. Poorman, Purdue University, Prof. of Mechanics, Staff Member
C. H. Cather, West Virginia University, Asst. Prof. of Mechanics
Edward Taylor, Pomona College, Assoc. Prof. of Mechanics
I. F. Waterman, Oregon State Agricultural College, Asst. Prof. of Mechanics and Materials
H. E. Hartig, University of Minnesota, Asst. Prof. of Mathematics and Mechanics
T. E. Pettengill, University of Detroit, Instructor in Mathematics
H. E. Mayrose, University of Detroit, Prof. of Drawing
Curtis Merriman, University of Wisconsin, Assoc. Prof. of Education, Educational Adviser on Staff

Row No. 3 from Top.

R. D. Campbell, Southern Methodist University, Asst. Prof. of Mechanical Engineering
H. B. Wilcox, University of Minnesota, Asst. Prof. of Mathematics and Mechanics
LeRoy Tucker, Clemson Agricultural College, Prof. of Mechanics
W. B. Johns, Jr., Georgia School of Technology, Asst. Prof. of Mechanics
W. E. Brooke, University of Minnesota, Prof. of Mathematics and Mechanics
H. P. Boykin, Virginia Military Institute, Asst. Prof. of Civil Engineering and Drawing
L. M. Becker, Hibbing Junior College, Head, Department of Mathematics and Mechanics
D. M. Bavly, North Dakota Agricultural College, Asst. Prof. of Mechanical Engineering
L. N. Field, Michigan State College, Assoc. Prof. of Drawing and Design
C. S. Slichter, University of Wisconsin, Dean, Graduate School, Staff Member
E. R. Maurer, University of Wisconsin, Prof. of Mechanics and Chm. of Dept., Director of Conference
E. M. Terry, University of Wisconsin, Assoc. Prof. of Physics, Staff Member
F. G. Person, Colorado State Agricultural College, Prof. of Physics
W. W. Wegner, Stanford University, Instructor in Civil Engineering
C. A. Wiepking, University of Wisconsin, Instructor in Mechanics

Bottom Row.

S. M. Woodward, State University of Iowa, Prof. of Mechanics and Hydraulics, Staff Member
N. H. Winde, Swarthmore College, Instructor in Engineering
R. S. Tait, University of Kansas, Assoc. Prof. of Mechanical Engineering
F. R. Stewart, Cleveland Y. M. C. A. School of Technology, Prof. of Mechanical Engineering
M. K. Snyder, State College of Washington, Prof. of Sanitary Engineering
E. E. Moots, Cornell College, Prof. of Mathematics and Engineering
H. J. Kersten, University of Cincinnati, Instructor in Mathematics and Drawing
L. F. Van Hagan, University of Wisconsin, Prof. of Railway Engineering, Secretary of Conference
F. E. Turneaure, University of Wisconsin, Dean, College of Engineering, Staff Member
Benjamin Spieth, Kansas State Agricultural College, Asst. Prof. of Mechanics
E. R. Dawley, Kansas State Agricultural College, Asst. Prof. of Applied Mechanics
C. F. Gross, University of California, Assoc. Prof. of Marine Engineering and Naval Architecture
J. H. Robert, Kansas State Agricultural College, Prof. of Applied Mechanics

Left to Right.

Upper Row.

G. H. MacCullough, Worcester Polytechnic Institute, Asst. Prof. of Mech. Engineering
A. P. Richmond, Dartmouth College, Asst. Prof. of Civil Engineering
H. W. Merritt, Cooper Union, Instructor in Physics
H. W. Leet, University of Rochester, Asst. Prof. of Drawing and Machine Design
E. V. Howell, Cornell University, Asst. Prof. of Mechanics
F. T. Tingley, Bucknell University, Instructor in Electrical Engineering
F. H. Evans, Rochester Athenaeum & Mechanics Institute, Director of Course Development
N. C. Riggs, Carnegie Institute of Technology, Prof. of Mechanics
J. A. Bullard, U. S. Naval Academy, Professor of Mathematics
J. E. Mulligan, Massachusetts Institute of Technology, Instructor in Elec. Engineering
E. P. Slack, Polytechnic Institute of Brooklyn, Asst. Prof. of Physics
Eric Nygard, Union College, Instructor in Civil Engineering

Row No. 2 from Top.

J. H. Dyble, Case School of Applied Science, Instructor in Mechanics
F. L. West, Mount Allison University, Prof. of Engineering
W. A. Gilmour, University of Akron, Asst. Prof. of Coordination
F. B. Scheil, University of Pennsylvania, Instructor in Mechanical Engineering
I. H. Prageman, State University of Iowa, Asst. Prof. of Mechanics and Hydraulics
F. E. Holmes, State University of Iowa, Asst. Prof. of Mechanics and Hydraulics
J. E. Lothers, Oklahoma A. and M. College, Asst. Prof. of Civil Engineering
W. D. Emerson, Norwich University, Assoc. Prof. of Engineering Mechanics
W. J. Conley, University of Rochester, Asst. Prof. of Applied Mechanics
P. G. Laurson, Yale University, Assoc. Prof. of Engineering Mechanics
J. B. Butler, Missouri School of Mines, Assoc. Prof. of Civil Engineering
J. B. Jones, Virginia Polytechnic Institute, Asst. Prof. of Experimental Engineering
K. G. Merriam, Worcester Polytechnic Institute, Instructor in Mechanical Engineering

Row No. 3 from Top.

H. A. Shaffer, Bucknell University, Assoc. Prof. of Electrical Engineering
F. N. Weaver, Tufts College, Asst. Prof. of Mechanics
J. S. Lambie, University of Pittsburgh, Assoc. Prof. of Civil Engineering
F. J. Converse, California Institute of Technology, Instructor in Civil Engineering
A. H. Repscha, Drexel Institute, Instructor in Mechanical Engineering
Andrew Simpson, Swarthmore College, Instructor in Mechanical Engineering
R. C. Hudson, Clarkson College of Technology, Asst. Prof. of Physics and Drawing
Z. R. Bliss, Brown University, Asst. Prof. of Engineering
A. P. Powell, Pennsylvania State College, Instructor in Electrical Engineering
J. W. Breneman, Pennsylvania State College, Instructor in Civil Engineering
S. D. Barclay, Pratt Institute, Instructor in Mechanical Engineering
W. J. Cox, Yale University, Asst. Prof. in Engineering Mechanics
T. F. Hickerson, University of North Carolina, Prof. of Civil Engineering

Bottom Row.

C. L. Walker, Cornell University, Prof. of Sanitary Engineering, Sec'y of Conference
W. J. Risley, Colorado School of Mines, Prof. of Mathematics and Mechanics
E. W. Rettger, Cornell University, Prof. of Mechanics, Staff Member
C. F. Scott, Yale University, Chmn. Board of Investigation & Coordination, S. P. E. E.
D. S. Kimball, Cornell University, Dean, College of Eng., Director of Conference
J. E. Boyd, Ohio State University, Prof. of Mechanics, Staff Member
R. M. Stewart, Cornell University, Prof. of Education, Educ. Adviser on Staff
W. S. Franklin, Massachusetts Institute of Technology, Prof. of Physics, Staff Member
H. P. Hammond, Assoc. Dir. Investigation, S. P. E. E.
C. A. Wheeler, Connecticut Agricultural College, Prof. of Mathematics

IMPRESSIONS OF THE SUMMER COURSE FOR TEACHERS OF MECHANICS.

BY R. L. SACKETT,

President of the Society.

My visit to the Cornell Summer Course for teachers of the Principles of Mechanics on Monday, July 11, was very convincing.

The instruction was well organized, and consisted of morning demonstrations, afternoon seminars, and a few evening speakers. The most important principles were taken up, and methods of presentation were analyzed. In the afternoon problems were used to illustrate principles and to point out relationships. A good variety of solutions was offered and a critical attitude was evident. Those in attendance were alert, enthusiastic and constructive.

Professors Boyd, Franklin and Rettger were excellent leaders. Every detail of program and of arrangements for entertainment had been carefully worked out. Cornell University through Dean Kimball had provided excellent accommodations which lent much to the enjoyment of the course.

There was a fine association of young and old teachers—a surprising proportion were mature men of experience. Many friendships were formed which will be lifelong.

I was impressed with the fine spirit which pervaded this pioneer enterprise and am convinced that it—and the course at Wisconsin University—will exert a very healthy effect on engineering education. These are but the forerunners of other progressive steps by the S. P. E. E. to raise the standards of instruction. No other movement has had quite the promise that this initial course has had.

I hope that equally strong support will be given by our leading institutions to whatever Dr. Wickenden and Professor Hammond backed by the Committee may propose as the next step forward.

REPORT OF CHAIRMAN, CHARLES F. SCOTT, BOARD OF INVESTIGATION AND COORDINATION, SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. PRESENTED AT THE 35TH ANNUAL MEETING, UNIVERSITY OF MAINE, ORONO, MAINE, JUNE 27–30, 1927.

I. Retrospective View of Board's Activities.—In 1922 the Board of Investigation and Coordination was appointed by the Council and began to formulate plans and negotiate for funds. At the Ithaca meeting, in 1923, the Society pledged active support of a study of engineering education if the Carnegie Corporation should favorably act upon the recommendation of its President, Dr. Pritchett, that it make a grant of funds. In October, a grant of $108,000 for a three-year program was made and in the following month, W. E. Wickenden was appointed Director of Investigation. H. P. Hammond was appointed Associate Director the following June.

The period to the beginning of 1927 was devoted to a program of survey and investigation in which approximately 140 engineering schools and various other agencies cooperated. A supplemental grant of $10,000 by the Carnegie Corporation in 1926 is set aside for publication.

The Board at the outstart planned a five-year program. Three years have been devoted to investigation. Two years more are being devoted to the formulation of the report and to the inauguration of activities as the outgrowth of the investigation. The financial support for this period is considered under another heading.

II. Board Membership and Meetings.—The membership of the Board continues with the same regular members as last year: M. E. Cooley, D. S. Kimball, C. F. Scott, F. E. Turneaure, D. C. Jackson, the President and the Secretary; and the members representing general education, Frank Aydelotte and C. E. Seashore. The Director and the Associate Director

have their headquarters in the Engineering Societies Building.

The Board held a three-day meeting at Pittsburgh in October dealing principally with a report to the deans and executive officers at Washington in November; it held a session in connection with the Washington meeting and there was a two-day meeting in May at Pittsburgh devoted especially to the report to be presented at the Orono convention. Many matters have been handled by correspondence, including the submission of preliminary reports and of proofs for review and comment. The Staff has had numerous conferences with individual members of the Board, both in New York and at their homes. The Chairman has been in frequent contact with headquarters and has attended several conferences with the Secretary and the Director in Pittsburgh and in New York. Members of the Staff have visited a considerable number of schools and have attended sectional meetings of the Society.

III. Publication and Reports.—The results of an investigation are usually not made known until a final report appears. In our project publication has been continuous; the monthly Journal of the Society has presented preliminary plans, progress reports, articles, bulletins and the like. The engineering, the educational, and the general press have given publicity to our activities. Thus the fruits of our work have been immediate. Data resulting from the factfinding studies have appeared also in nine bulletins issued in November, 1926, and in three additional recent bulletins, and there are to be a number more. A preliminary report of the Board appeared in November and a second report at the Orono convention; others are to follow. All this material is to be brought together in unified final form.

IV. Washington Conference.—An outstanding event of the year was the Washington conference at which the Board presented a report to a meeting of the Deans and Executive Officers of the engineering schools. Approximately 100 schools were represented. The report proposed several lines of activity which might be taken up by the engineering schools. As

a result committees were appointed in 85 schools for special studies, principally relating to the recommendations of the Board based on the assembled data and taking into consideration the local conditions.

V. Summer Schools.—The project for summer schools, suggested by the Staff and recommended to the Board by the Society's Committee on Teaching Personnel, was presented to President Keppel of the Carnegie Corporation. Its merits appealed to him and in March the Corporation made a grant of $7,500 for two sessions of the summer school which are to be held in Ithaca and in Madison during three weeks in July. Professor Hammond has let his diligence well nigh equal his zeal in working out the plans. The topic for this year's sessions is Mechanics. Groups of teachers in this and closely related subjects will have the leadership of expert teachers and of professional engineers and educators. It is aimed to stimulate the study of the educational methods and to determine the distinctive methods to be employed in the field of mechanics. Consideration will be given to elementary training and to advanced phases of the subject, as well as to its relation to other subjects and to engineering practice. But aside from the particulars of the course the coming together of groups of teachers of a fundamental subject should be productive of interest, insight and inspiration. Engineering education has suffered from too much emphasis on engineering and too little on education. The great need is better teachers and better teaching. This project goes directly to the vital factor in the engineering schools and promises to vitalize it.

Early in April we feared we might not secure the desired quota of 30 at each session. But we have received over 100 applications and the limit has been raised to 40 at each school. A record of these sessions is to be made, although it is impossible to translate round table discussion to the printed page. We are inaugurating in these schools a new factor in engineering education which may be continuing and cover many fields.

VI. Financing the Two-Year Period.—The goal of the pres-

ent Board, as already stated, is the consummation of the originally planned five-year project. Three years of investigation, under the Carnegie grant, have been supplemented by a two-year period for the inauguration of constructive action based on the findings of the first period. Funds are supplied by general subscription.

It was reported a year ago that the Carnegie Corporation, while expressing full satisfaction with what we were doing, did not find itself in position to continue financial support. However, the cordial attitude of the engineering societies was most promising. A telegram from Calvin W. Rice stated that the presidents of the four Founder Societies would cordially recommend endorsement and appropriations by their societies. A letter from Alfred D. Flinn, Director of Engineering Foundation, expressed a readiness to help. Favorable action followed. The five organizations are collectively contributing approximately $6,000 for each of two years; Engineering Foundation is also cooperating with our Fund Committee in seeking contributions and in acting as treasurer of the fund. Mr. Flinn has heartily devoted himself to the project. His zeal and his patient endeavor merit our appreciative thanks.

This attitude of the engineering societies is most heartening to our project. They knew what we were doing; their headquarters and ours were in the same building; they had participated in an important part of the investigation; their endorsement promises a new and fruitful cooperation between the schools and the profession.

Our situation has been presented to engineering and to industrial interests. Sympathetic and sometimes generous response has come notably from those who are in touch with engineering education and with our present project. The list of contributors to our two-year fund is as follows:

Engineering Foundation,
American Society of Civil Engineers,
American Institute of Mining Engineers,
American Society of Mechanical Engineers,
American Institute of Electrical Engineers,
Adams, Edward Dean,

American Brown Boveri Electric Corporation,
American Telephone and Telegraph Company,
American Water Works and Electric Company,
Babcock and Wilcox Company,
Brown and Sharpe Manufacturing Company,
Carnegie Corporation (for summer schools, 1927),
Detroit Edison Company,
General Electric Company,
Guggenheim, Daniel, Fund for Promotion of Aeronautics,
Insull, Samuel,
Lewisohn, Samuel A.,
McGraw, James H.,
Sangamo Electric Company,
Sharpe, Henry D.,
Sullivan Machinery Company,
Union Carbide Company,
United Shoe Machinery Corporation,
Western Union Telegraph Company,
Westinghouse Electric and Manufacturing Company.

The replies from many other industries and industrial leaders, however, indicate that engineering education is not understood and appreciated. They regard our project as foreign to their affairs, although we are dealing with the fundamental problem of preparing men for industry which it should be their active concern to support. Their attitude apparently emphasizes the importance of our general project.

More funds are needed for carrying forward our plans on a minimum scale. But we should be in financial position to carry out several special projects including summer schools in 1928. The Fund Committee asks assistance of members and friends in order that we may secure full benefit of the plans already in hand.

VII. The Situation Present and Prospective.—"No Society ever had before it a larger and more urgent task than yours." In these words we were greeted by the President of the University which was host to our convention six years ago. And as the years go by our task becomes larger and more urgent.

We are in a transition period—the transition from the century of mechanical power to the century of electrical power. The steam engine brought industrial, economic and social revolution and a readjustment of the philosophies and practices of life as an easier way of doing more through the aid of power and machinery and created a new freedom—freedom from the immemorial bondage of toil, freedom for the development of the intellectual, the aesthetic and the spiritual life of mankind. It was the adventure of the world in Power—the great event of the nineteenth century—which made it so different from those which had gone before. And now the expanding use of machinery and power, available through new prime-movers and the extension of electrical systems increases output so that the wealth produced in a few years equals that of the past hundred. In all this the basic activities are engineering. In applying advancing science to the materials and forces of nature the engineer has brought about a new standard of living in a civilization whose very existence depends upon the ability and the skill of the engineer.

And beyond these physical elements the engineer has been a pioneer in extending the scientific principles found useful in dealing with nature to the field of human endeavor. Scientific organization and management, engineering methods in dealing with administrative and economic problems, and in human relations—all these are matters in which the engineer is making his contribution. To be useful an invention must be operative; a machine must be economically productive and an enterprise must be beneficial. The engineering profession must concern itself with the ultimate usefulness of engineering enterprises as measured in human values and with the citizenship and statesmanship which reconstructs industrial, economic, social and humanistic relations to the new adjustments which the advances in applied science make essential.

The trained engineer is distinguished for his training rather than his knowledge. His ability to meet new situations, his facility in formulating problems, his method of accomplishment—these are the things that really count. Herbert Hoover

is a great engineer because as professional mining engineer he is a technical expert in a particular field but in a larger sense he is an engineer because he brings the engineering method to bear on the general problems of industry, of commerce, of governmental administration and of public welfare.

Education for engineering in its restricted technical and professional field becomes more intricate as the branches of engineering increase in number and the science and technology of each expands and as the magnitude and responsibilities of engineering enterprises become greater. But engineering education is a still greater problem when considered as presenting a type of professionally oriented training which is to fit men for a wide field of related as well as intensive engineering activity. Engineering is a function in society as well as a technical profession.

For thirty-four years this Society has been a common ground where engineering teachers have discussed their problems, but of late we have attacked these problems in a larger, more systematic, more comprehensive way. The engineering schools, through the Society and its Board of Investigation and Coordination, have made a fact-finding engineering survey of the present situation from which we may see what we are doing, determine what we should do and work out the best way of doing it.

We have found that engineering education is fundamentally sound; it calls for no drastic renovation; but there are many opportunities for its betterment. We have enlightening facts regarding our entering students, our courses, our facilities, our teachers, our graduates, the preparatory schools, related professional schools, the educational systems of other countries, our relations to the engineering societies and to industry and many other matters. We have found that the Society, in the past, was attempting to make bricks without straw. We find a serious, earnest group of teachers, but not of the general standard which adequate compensation would ensure. We find the ideals and accomplishments of the engineering schools are not generally understood—we lack publicity. We

find engineering schools are like isolated little kingdoms, not closely interrelated and with meager contact with other schools. We see the need of a more effective relation with engineering societies and practicing engineers and with industry. We need better relations with preparatory schools and with postgraduate work both in graduate schools and in industry. We see the need of a new sort of economics for engineering students. We need teachers of skill and of vision and we appreciate the tone which can be given to groups of teachers through summer schools.

Our project is bringing engineering as a whole into clearer perspective. We can do our work better as we see how our part fits into the whole and as we realize that we are training men who are to carry on—they are to build a future out of the present, they are to construct and to operate; they are to deal with the economic, industrial, and administrative problems and the questions of public policy which engineering activities have produced. We are moulding the men who will have to meet the outstanding problems in a transitional and critical period.

We have been finding the facts. Finding the facts is essential; it is arduous, but it is simple compared with their analysis, the decision as to what to do and the task of action which now lie before us. Our most important accomplishment is the demonstration of what engineering schools can do through coordinated effort with the aid of a central staff and financial support. As engineering educators we are finding that cooperation—the modern engineering method—is fruitful in our own field. Our larger problem now is to plan for the future.

The situation is admirably summed up in a memorandum of the Director to the Board from which the following paragraphs are condensed:

There has been a slackened pace in engineering education beginning some years prior to the war. Agriculture and business education have had spectacular expansion, while medical and dental education have been lifted from the proprietary

slough to the most advanced standards and munificently endowed. While engineering education was making only modest and sporadic progress the advance of scientific discovery, applied technology and industry and the rise of professional consciousness among engineers went forward at an unprecendented pace.

The negative situation existing when the Board was formed pointed to the inadequacy of isolated individual effort in educational affairs. We were like an army with no general staff. We had many excellent schools, but no adequate system of technological education. We adhered to some educational tactics, but this Society, the only potential overhead agency in the entire field of engineering education, with its limited income and mounting costs, was unable to attempt a larger program.

The creation of the Board and especially the Carnegie grant of funds acted as a vitalizing stimulus. After trial of a centrally directed broadly cooperative program it becomes evident that a permanent, central agency is essential for insuring that the evolution of engineering education may be a continuing process.

The Board has crystallized its views in these terms:

The work of the Board of Investigation and Coordination which will soon be brought to a close has demonstrated that the faculties of engineering schools can cooperate with great effectiveness in the study of problems of engineering education when aided and guided by a central directing board and staff. If engineering education is to progress, study of its problems must continue by individuals, faculties, by this Society and by others, but our recent experience makes very clear that the best results can be obtained, and obtained most economically in the long run, by concerted action through a central agency. There are, of course, many problems that can be studied by individual teachers, by local groups, and by committees of this Society. The efficient administration of these studies calls for more aid through a central staff than the regular income of this Society can support. But there

are other subjects of the greatest significance to engineering involving relations with the professional societies and with industry which can hardly be developed at all except through a well-supported staff for research and publication; such subjects as a general development policy for engineering education, cooperation in educational achievement outside of regular scholastic processes, promotion of public interest in engineering education, cultivation of international relations and reciprocity.

When fully worked out such a central organization would appear to call for

1. A Board of Direction.
2. A permanent research and clerical staff and experts on special appointment.
3. A joint liaison board with representation from this Society, from the professional engineering societies, and from industry through some of its recognized channels.
4. An endowed Foundation for Engineering Education to receive, hold, and administer trust funds and to employ the income through this Society for the advancement of engineering education in ways that supplement the activities of the individual engineering schools and colleges.

It is therefore recommended:

That steps be taken to provide for an adequate central staff to engage in research in engineering education, to afford general information in regard to engineering education, and to correlate the activities of this Society with the interests of engineering profession, of industry, and of the general public.

To make possible such a program, it is further recommended:

That the Society seek at once to obtain support to the amount of not less than $30,000 a year for the maintenance of this instrument of educational research, information, and

advancement, preferably in the form of a permanently endowed foundation.

Committee on Policy:
F. L. BISHOP,
H. S. BOARDMAN,
A. A. POTTER,
C. F. SCOTT,
G. B. PEGRAM, *Chairman.*
(John G. Bowman unable to attend.)

The Society has endorsed and undertaken to carry out this program; it has accepted an unprecedented opportunity to make its adventure of the past few years the beginning of a new era in engineering education.

SECOND REPORT OF THE BOARD OF INVESTIGATION AND COORDINATION*

I. ENGINEERING EDUCATION—A UNIFIED VS A DIVIDED PROCESS
II. THE QUESTION OF A LONGER ENGINEERING CURRICULUM

Summary of Issues and Conclusions.†—This report deals with two distinct but related issues which now confront the colleges of engineering. The first and more fundamental is the alternative between a unified and a divided educational process; the second is the question of the normal length of the engineering curriculum.

I. A unified educational process implies a curriculum in which humanistic, scientific and technological studies are combined into an orderly whole, constituting a complete and self-contained branch of higher education under unity of supervision. A divided process implies a distinct pre-engineering curriculum under separate auspices and an engineering curriculum set up on purely technical lines, a plan corresponding to the present educational scheme in law, medicine and dentistry.

The Board is of the opinion that the engineering colleges in general may best fulfill their purpose by providing under their own auspices an educational program which is complete in itself and which may be entered direct from the secondary schools; that this type of program supplies the norm in engineering education; but that facilities should be afforded for the admission to advanced standing of students who desire a more extended general academic training before entering upon the study of engineering.

* Presented at the 35th annual meeting of the Society for the Promotion of Engineering Education at the University of Maine, June 27–30, 1927.

† *Note:* Except where specifically noted, the term engineering education is employed in this report to denote a college program leading to a degree. It is recognized that there are other important divisions of engineering education, in its comprehensive sense, which lie beyond the scope of this discussion.

II. The issue concerning the length of the curriculum grows out of the accepted principle that more than four years of preparation are needed to equip men for creative leadership in the engineering profession. The alternative lies between a longer prescribed program, to be pursued in full or in part by all students, and a normal undergraduate program as a base with a variety of supplementary programs to fit different needs and preferences.

The Board is of the opinion that it is advisable to preserve the usual distinction between undergraduate and post-graduate programs and that the undergraduate program should be self-contained and lead to a degree. Opportunity should be afforded and encouragement given to students of promise to extend their formal training by means appropriate to their aptitude, ability and choice of a career, such as the voluntary election of additional humanistic studies, the pursuit of post-graduate study in a fully qualified institution, or through orderly studies pursued in conjunction with engineering experience. Four years is regarded as the normal length of the undergraduate program. In many cases this program may be divided advantageously into two stages both reasonably self-contained, and under the same supervision, in order to provide an intermediate goal and facilitate a selective process of admission to the upper years.

PART I. ENGINEERING EDUCATION—A UNIFIED VS A DIVIDED PROCESS

Purposes of Proposals to Divide the Curriculum.—Those who challenge the present status of the engineering colleges and their self-contained educational program usually propose a segregation of the program into two distinct parts, the first a general academic training under non-engineering auspices, and the second a strictly technical curriculum in engineering, comparable to those in law and medicine. This proposal is made principally by educationists on abstract grounds, but is echoed occasionally by engineers and industrialists. The intent of these proposals is to include engineering education in a general movement of somewhat various aims:

To raise the cultural level of the professions;

To sift all students to more homogeneous standards before admission to professional courses;

To postpone the final choices of departmental or professional specialization;

To make the arts college, or a similar unit, the central feature in university organization and the vestibule to all specialized instruction;

To extend secondary education, either in or outside the universities, by two years;

To professionalize the advanced instruction in all academic departments;

To transfer all general introductory instruction to junior institutions.

The critics of the present unified program of the engineering colleges seldom fail to point to the examples of a divided educational process in legal, medical, dental and theological education, and to advocate that engineering education should be organized on the same plan in order to maintain high standing as a branch of professional education.

Criticism of Assumptions Underlying the Divided Program.—The assumption is commonly made that certain subjects are inherently cultural and others are not, and that any degree of professional orientation puts a program beyond the pale of "broad" education. These assumptions seem to be incidental to narrowly conventional definitions of culture. The engineer would maintain that culture cannot be restricted to the fine arts and personal graces, however desirable for the enrichment of life, but must be conceived equally in terms of insight into the social bearings of one's calling, qualifications for efficient team-work with men of other callings, and the ability to invest one's work with large social values. Culture, so conceived, ought not to be divorced from professional preparation. Granting that the present means to these ends in the engineering curriculum may be greatly improved, it does not follow that they would be bettered through dissociation, but rather that the cultural possibilities inherent in engineering education should be more fully explored and developed.

Another assumption is that it would be profitable to extend the student's preparatory education by one or two years, and that more valid choices of specialization would result. European examples are often cited in support of this position, but the fact that this higher scholastic level is normally reached abroad at the age of eighteen is often overlooked. The age level and stage of mental maturity mark a more significant threshold to professionally oriented studies for the engineering student than the level of scholastic attainment. The urge to prepare for a technological career normally appears at or before eighteen, rather than later, It is necessary to employ these natural enthusiasms of the student as incentives for a long and arduous formal training under the rising pressure of his instinctive urge to do, to create, to deal with tangible and realistic situations, to achieve economic independence, and to mate at a normal age. Furthermore, as a student, his time is subject to a law of diminishing returns, and a balance must be struck between formal education and training through actual experience.

What the engineering student needs at the outset is not so much a widening of his intellectual horizons as a discipline in more intensive and directed methods of mental work; the broadening process is much more effective if distributed over the entire educational program. Experience indicates that a faulty perspective of cultural values on the part of the student is more readily corrected by sympathetic guidance in an engineering college with adequate provision for humanistic studies in the later years of its curriculum, than by consigning him to a probationary period in an arts college.

A further assumption is that the engineering colleges would profit greatly by a preliminary sifting of their students. Doubtless they would if the sifting process were based on a valid trial of interest, aptitude and ability. However, the actual results of a divided program, in which another type of college is made to serve as a vestibule to engineering, have been seriously disappointing; it appears that the spark of enthusiasm for engineering is quenched more often than it is kindled and that more students are diverted from engineering through

prejudicial influences than are directed to it through constructive educational guidance. This result is reflected in a marked shrinkage of enrollments and graduations in engineering under the divided plan without indications of compensatory gains in the qualifications of graduates, when comparisons are made between educational programs of equal total length. The unified engineering program, on the other hand, offers tangible means of try-out and guidance to the student with tentative engineering objectives, and exacts little penalty of the student who transfers to another educational program within a reasonable period.

Are Precedents in Education for Other Professions Relevant?—Technical training for the professions of law, medicine, dentistry and, to a less degree, the religious ministry, is distinctly set off from the processes of general education and all the first-class schools preparing for these professions require from two to four years of general college work for entrance. The accentuated professional status of these schools and the long formal training in two stages are often upheld as examples to the engineering colleges. It is fitting to point out, however, that there are few if any parallels involved, apart from the common use of the term "profession."

First, there is striking dissimilarity of historical backgrounds. Education for law, medicine and dentistry had its origin in a system of pupillage or apprenticeship, out of which there developed an extensive system of private proprietary schools of strictly technical character. When these schools were later assimilated to a university status they preserved their separate identity through a sharp division of the educational process into pre-professional and professional stages and in many cases established themselves on separate premises. In contrast, the type of engineering education which developed in American colleges has been from its origin an inclusive educational process, instituted and directed by professional educators, conforming to university standards, and more academic than vocational in type. While originating in distinct polytechnic schools of university grade, it early gained recognition and place in institutions of the broadest academic

character and has held and extended this position during a period of eighty years.

The early curriculum in American colleges of engineering was conceived as an alternative and a challenge to the traditional classical discipline. Unlike the strictly professional disciplines mentioned above, engineering education has never been under the exclusive domination of a professional group; non-engineers have shared equally with engineers in shaping its character and destiny. It is significant that early engineering curricula contained little of the technique of engineering practice, but emphasized an objective approach to the physical sciences with a view to the economic use of materials and sources of power in nature, as contrasted with a subjective concern with the organization of systems of scientific knowledge. The science of engineering, rather than the art, has consistently dominated the engineering curriculum and even to this day the materials for a complete discipline for the practice of engineering have never been developed in systematic form.

Second, the professions concerned are of dissimilar nature. Law, medicine, dentistry, and the religious ministry are strictly defined professions, based on a single level of responsibility and largely concerned with a service by individuals to individuals. Each has a distinctive social and legal status, and the first three have monopolistic rights and privileges under the law, which make restrictions as to entrance a necessary protective measure for society. The auxiliary or subprofessional services related to these professions are in the hands of distinct groups and there are no open promotional routes from group to group. These conditions tend to fix the forms of professional education in a series of standard patterns. In contrast, engineering—concerned with the economic use of materials and energy—is one of the very general functions in social economy, and not the exclusive function of a well-defined professional group. It has many levels of responsibility and no clear distinction has ever been drawn between the professional and the auxiliary levels. The profession of engineering is self-constituted and traditionally

open and inclusive in its organization. Promotional routes run through all grades of responsibility and legal restrictions as to entrance are relatively nominal.

Third, the professions concerned have different relations to educational practice and policy. Law, medicine and dentistry are represented by strong central organizations, able to formulate and largely able to impose a strict educational policy in connection with legal restrictions on entrance to professional standing. Within the last twenty years each of these professional bodies has had occasion to take strong protective measures in the face of a common problem, namely the flooding of the profession with the poorly educated and meagerly trained graduates of low-grade schools operated for profit. It was urgently necessary to raise the qualifying levels of general education, up-grade the standards of technical training, bring the schools under university auspices, impose proper limitations of numbers and introduce selective processes to guarantee suitable personal qualifications of recruits. The chief means chosen to these ends has been the prescribing of two years or more of college work as a prerequisite of admission to highly specialized professional curricula. The engineering colleges, on the other hand, have been almost wholly under university standards and educational auspices. The elements of general education included in engineering curricula have long been equivalent to those now prescribed for admission to all but a few exceptional schools of law and medicine. There is no centralized body in the engineering profession which could formulate and enforce a strict educational policy. Engineering enrollments have been relatively stationary for many years and there has been no flooding of the profession by an excess of recruits. In short, there has been no need of drastic reform in engineering education to protect or advance the interests of the profession, but only of healthy evolution. The profession has never undertaken to bring the educational process under its direction or control.

Fourth, the division of an educational program implies that its professional stage is designed exclusively to fit students for definite professional careers. This is not the sole pur-

pose of engineering education. As previously stated, engineering is actually one of the most general functions in social economy, and not exclusively a form of professional service. There would be no conceivable gain to society in making scientific technology the monopoly of a restricted professional group, as in medicine and law, nor is there any inherent basis for limitation of numbers in technological education. On the contrary, there is positive social gain in the wide diffusion of men with engineering training throughout the entire range of industrial, commercial and public activity. The professional element in engineering education, which gives it characteristic form and direction and marks it off definitely from a loosely grouped body of scientific studies, is of great value, but the undergraduate program is conceived not so much as a specific professional discipline as a professionally oriented form of education. It is significant that engineering training qualifies graduates to function in the whole range of directive responsibility in industry and public works; less than one-third remain permanently in predominantly technical work and less than one-tenth establish themselves in an individual professional capacity. Present tendencies relative to curricula, teaching processes, personnel practices, student activities and the enrichment of institutional life in the engineering colleges are in marked contrast to the practices of the strictly professional schools of law, medicine and dentistry, and testify to the ideal of serving the student as an individual rather than fitting him into a pre-determined professional mold.

Present Status of the Engineering Colleges.—There are now more than one hundred and sixty colleges in the United States and Canada which offer complete engineering curricula leading to degrees. With two exceptions, Dartmouth and Columbia, these schools are all organized as undergraduate colleges, with or without associated post-graduate departments. Only four institutions in all have organized their curricula in two distinct stages under separate direction. There are nineteen polytechnic institutes such as Rensselaer and Massachusetts Institute, and seven colleges of mines as

Colorado (Golden) and Missouri (Rolla) which are devoted primarily to technological curricula and research and are committed by tradition and circumstances to an integral educational process. Forty-nine of the engineering colleges are included in the Land-Grant system established by the Morrill Act of 1862 with the intent of providing a liberal type of technical education which should be widely accessible to the industrial classes and should aid in investing industrial pursuits with a professional quality. The Land-Grant colleges have unquestionably been a powerful influence tending to hold engineering education to its original ideal of a unified educational process. Forty-two other institutions, exemplified by Lafayette and Swarthmore, are colleges devoted largely or exclusively to undergraduate studies and without distinct professional schools. Fifty-three engineering colleges, or slightly less than one-third of the total, are included in institutions with a university type of organization which provides for separate professional schools.

Considerations of Educational Efficiency.—The following summary touches briefly on many of the more specific aspects of the problem:

1. *Preparatory Education.*—The present tendency in the high schools is to sacrifice the type of intellectual formation requisite for rigorous analytical studies to a process of so-called enrichment and socialization of curricula. The engineering colleges now exert a corrective influence through distinctive entrance requirements which would inevitably disappear if these colleges should lose direct touch with the high schools and act through the arts colleges as intermediaries. The result would be the loss of one or more years of valuable time to the student, and a certain diminution of the quota of students qualified to enter upon engineering studies.

2. *Motivation.*—One of the marked values of the unified program, entered directly from the secondary schools, is that it capitalizes the student's natural motivation. To keep the student longer away from studies which bear on his life purposes tends to prolong a juvenile attitude toward education

at a time when he needs to learn the method of intensive, directed effort.

3. *Scientific Grounding.*—Mathematics and physical sciences are an organic part of the engineering curriculum and not mere formal prerequisites to be "passed off." The building up of these foundations in an unbroken sequence is one of the most essential conditions of effective engineering education. There is need for a more thorough mastery of these subjects and for greater facility in their use as tools than are considered requisite for college students in general. The engineering student, as a type, learns principles best in conjunction with their applications, a condition which would not obtain in the divided program.

4. *Sequences of Studies.*—Effective sequence of essential scientific and technological studies requires four consecutive years; it does not occupy them fully, however, and affords time for a parallel sequence of humanistic studies, which gain from the student's advancing maturity and add to his insight into the broader social implications of technology. In the divided curriculum cultural studies lose in significance through being dissociated, and technological studies are likely to be crowded into a sequence too brief for the best results.

5. *Adaptation of Program to Varying Needs.*—Programs of engineering education of varying length and character are needed to fit different requirements. For the present, it may be impracticable to set apart different types of institutions to serve these several ends, and the engineering colleges may need to approximate to them by a program of adjustable length. The unified plan, with humanistic, scientific and technological studies distributed through the curriculum in continuous sequences, lends itself to these purposes.

6. *Time Economy.*—The advantages of time economy are all on the side of the unified program, which affords greater assurance of close articulation of preparatory studies and college work and of purposeful and intensive effort than can be expected in a non-engineering college. Unless a pre-engineering curriculum is given over very largely to scientific preparation, at least five years in all will be required to accomplish the present ends.

7. *Advanced Studies.*—The unified program affords a clear distinction between undergraduate and post-graduate work. The divided program, however, requires a longer period to accomplish the same ends, thereby tending to confuse deferred undergraduate studies with real advanced work and lessening the margin of time and the incentive to pursue it. When undergraduate and advanced studies are clearly separated, there is greater probability that students will seek out special centers of advanced work for the sake of exceptional facilities, a condition that deserves to be encouraged.

8. *Educational Demand.*—There is a large and wholly legitimate demand for technological education of moderate length and exactions. It is important to strengthen and extend the base of technological education through larger development of a system of training of high quality but of intensive character aiming at fairly immediate utility, such as is now provided by a small group of non-collegiate schools. It is important to stabilize on the undergraduate level a considerable majority of the present engineering colleges founded to make and keep technical education accessible to the great body of the public. Failure to do so will lend encouragement to proprietary schools of dubious quality and to institutions which subordinate intellectual ideals to welfare motives.

9. *Transition of Graduates to Active Life.*—Experience indicates clearly that it is bad for morale to delay too long the adjustment to practical life or to make the transition from a highly intellectual type of college program to a necessarily rudimentary experience too violent. There is a definite possibility of keeping many promising men too long in college. These considerations apply with less force to men entering upon an individual professional status or work of a research character, but engineering colleges cannot limit themselves to such groups. To do so would break contact with the normal operating functions of industry and public works, from which most of the increase of demand for graduates bids fair to come.

Summary of Argument.—The unified plan of engineering education has valid historical sanctions, is firmly fixed in status, and is consistent with the objectives of the engineering

colleges; it makes the most of the student's motivation, aids in the try-out of his educational and professional choices, and lends itself to adjustments of program to fit individual needs; it fits into the requirements of the public and industry and makes for time economy; it exercises a wholesome influence on secondary education and insures the requisite sequence of studies; and it subtracts nothing vital from the cultural ideals of education, but affords opportunity for a closer linking up of cultural and vocational interests. The circumstances which led to the adoption of the divided plan in other branches of professional training are almost wholly lacking in the case of engineering. A general abandonment of the present unified program would be a disrupting influence in educational organization and would have little support from the engineering profession. There has been no demonstration of the superiority of the divided plan on either cultural or technical grounds, when programs of equal total length are compared; and no convincing case has been made for its general adoption.

Defense of engineering education as a unified process should not be mistaken as a plea for uniformity. There is no inherent reason why all engineering colleges should be organized on the same plan or offer similar programs of studies. Standardized uniformity is sterile, but diversity makes for progress which is more often spread through experiment and example than imposed through mass movements. A comparison of engineering curricula of the unified type with present curricula in medicine and dentistry indicates that the engineering colleges enjoy greater freedom from standardization. Local circumstances may make a division between the engineering curriculum and the introductory general studies advantageous in particular institutions and it is well that the plan should be fully tried out. The actual trials thus far made have not achieved assured success and the more notable advances of recent years have been achieved in institutions which maintain a unified program.

PART II. THE QUESTION OF A LONGER ENGINEERING CURRICULUM

Past and Present Experience.—The four-year undergraduate engineering curriculum has been the dominant type of program in the American engineering colleges for eighty years. Efforts to establish longer regular programs have been made at intervals by a number of institutions of prominence, but have either been given up or have persisted with precarious success. Among the institutions which have tried and discarded longer curricula are Harvard, which maintained for eight years a Graduate School of Applied Science, Missouri, Wisconsin, California, and Minnesota. With the exception of certain special cases * there are but three institutions at present which actually maintain programs of more than four years as their principal practice. Dartmouth and Columbia admit the student to the engineering college after three years of work in arts, and credit one year in engineering toward the arts degree. The course in engineering proper is three years in Columbia and two in Dartmouth, and leads in both cases to the degree of "Engineer." Columbia, however, now offers an alternative plan whereby the degree of B.S. may be gained in four years and one summer. Northwestern gives its entire program of five years under the direction of the engineering college and awards the B.S. degree at the end of the fourth year, so that its practice differs only nominally from that of the eighty-one institutions which offer advanced work for graduates on an optional basis. There is therefore but one institution, *i.e.*, Dartmouth, other than certain cooperative schools, where the first degree in engineering cannot be gained in a four-year period, and that institution has enrolled of late but ten to twelve engineering students per year.

Seventeen institutions have definitely scheduled combined courses in arts and engineering of more than four years' dura-

* Eleven institutions have cooperative undergraduate programs extending over more than four years. Four colleges have a five-year program in one department and four-year programs in all others. One offers five-year programs for the degree of "Engineer" paralleling its four-year programs for the bachelor's degree.

tion, offered as an alternative to the regular undergraduate engineering program. In a number of cases combined programs are set up through an affiliation of two institutions. The proportion of students enrolled under this plan is relatively small. A considerable number of students voluntarily enter engineering colleges on advance standing from arts colleges, without a formal articulation of curricula, and many engineering colleges encourage this type of extended program.

Aims of Longer Curricula.—The efforts to establish longer required programs have aimed principally to advance the standards of engineering education on its humanistic and scientific sides, rather than to extend the technical instruction to a more advanced level, except in graduate schools. The institutions concerned have acted individually; no concerted effort to introduce a longer curriculum as a general practice has yet been attempted. The nearest approach to such action was taken by representatives of fourteen mid-western institutions in 1922, and set forth in the following resolution:

> "In order to meet the constantly enlarging responsibilities of the engineering profession, we favor an advance in engineering education at this time that shall provide five years of collegiate training for those engineering students whose aim is to become qualified to take positions as the creative leaders in the profession, and that such advance shall be made in substantial accordance with the following plan:
>
> "1. Include in the four-year engineering curricula a substantial proportion of fundamental and humanistic subjects, omitting if necessary a sufficient amount of the more advanced technical work. It is desirable that, as far as possible, the curricula in the different branches of engineering shall be sufficiently uniform to permit students to defer their final choice of a specialty at least to the end of the second year.
>
> "2. Add a fifth year of advanced work, mostly or wholly technical, and specialized to such an extent as desired.
>
> "3. The first four years of work shall lead to a bachelor's degree and the fifth year to an advanced degree in engineering."

Advanced Studies.—As stated above a large proportion of the engineering colleges offer advanced work following the completion of the regular undergraduate program. Almost without exception these institutions regard their four-year programs as normal and the fifth year as a period of post-graduate study. In some of these institutions, and notably in a few, the number of graduate students has been increasing steadily. There were almost exactly 1000 graduate students of engineering enrolled in American colleges in 1924–25. This

number is between ten and twelve per cent of the total of first degrees in engineering awarded at the end of the preceding academic year. Sixteen institutions awarded a total of 572 graduate degrees in engineering in 1924–25. Since that time the number of graduate students of engineering has increased appreciably. More than three-fourths of the present graduate enrollment is in ten institutions, pointing to a tendency to migrate to the stronger schools for special advantages at this stage.

Difficulties with Longer Curricula.—It has been the general experience that longer formal curricula have lacked the drawing power needed to insure a satisfactory numerical success; they have not attracted adequate groups of students in competition with normal undergraduate curricula in the same institutions or in others of equal rank. While these efforts have been made by distinguished institutions, there has been no instance where the superiority of teaching personnel or physical facilities associated with a longer curriculum has been so marked as to be the determining influence in the result. Moreover, it does not appear that efforts were made to assure strong moral or material backing for these experiments from the engineering professions and industries. Had these conditions been met, the outcome might have been different, but the fact remains that longer curricula have not succeeded in gaining a firm position on the strength of inherent superiority as an educational process.

There is a widespread desire among educators to provide a superior preparation, beyond the possibilities of a four-year curriculum, for students who give promise of developing into leaders of engineering and industry, but there appears to be little demand for a longer scholastic program for the average student. Many of the proposals for longer formal programs are assumed to have a selective basis; they are intended to apply to students of superior ability or to institutions of a distinguished character. Difficulties arise, however, when attempting to make such a segregation by formal means.

The tangible gains in providing a more extended training for selected men have been achieved largely on a voluntary

basis and in institutions which maintain the normal subdivision between undergraduate and post-graduate work. This gain has been made in about equal measure through the combining of courses in arts and in engineering on the student's own initiative, and through an increasing tendency to pursue post-graduate work. The admirable educational programs for graduates which have been developed by certain progressive industrial concerns have become important contributions to more extended education for selected men. The present tendency to associate these advanced courses in industry more closely with the graduate schools of the universities is a factor of large promise. These voluntary measures appear to be more successfully selective than any formal prescription for longer training, and to afford greater flexibility in fitting the educational program to individual needs.

Policy Suggested.—In the judgment of the Board an undergraduate program does not constitute in itself an adequate preparation for many of the higher forms of engineering activity, but it embodies the foundation subjects which constitute the essential basis of engineering education for the great body of students. Up to a certain point, it is both necessary and advantageous to organize the curriculum in a limited number of divisions which aim primarily at group needs; beyond that point it is essential that training should be highly diversified to meet the needs of individuals and of engineering requirements. The Board considers that the undergraduate program is as extended as can be given to good advantage to considerable groups of students and that further training should be largely diversified in length, type and setting. Furthermore, there is a need for many institutions to give thorough undergraduate instruction, but a relatively limited number of institutions with specialized facilities are needed for more advanced work. It would be wholly unfortunate to invite many substantial undergraduate institutions to inflate their programs, by setting up the standard of a five or six year engineering curriculum as a measure of educational respectability and standing.

When all factors in the situation are considered, it seems desirable to recognize the distinction between undergraduate and post-graduate work in engineering as normal, to encourage many institutions to offer the former and relatively fewer the latter type of instruction, to plan the undergraduate curriculum so that it may serve as a terminal program for the average student, to make an extension of this program optional with the student, and to encourage the student of promise to extend his formal training, either through the voluntary election of additional courses in humanistic subjects before or during the engineering curriculum, or through post-graduate study in a fully qualified institution, or through orderly part-time studies in connection with engineering experience. The commonest exceptions to the normal four-year program will occur in cooperative courses, where the undergraduate curriculum is spread over a longer period, and in programs which combine two distinct curricula, such as arts and engineering, engineering and business administration, and the like.

Undergraduate Curricula.—In accepting the four-year undergraduate program as a norm and a more extended program as optional, certain principles deserve to be recognized and stated:

1. The four-year curriculum should constitute an acceptable terminal program for the large body of students who wish a general engineering training, and properly leads to a bachelor's degree. In many cases the undergraduate engineering program may be divided advantageously into two stages, each reasonably self-contained, in order to provide an intermediate goal and to facilitate selective admission to the upper stage.

2. Students registered in the undergraduate engineering curriculum should have the privilege of extending the program to five years by the election of additional humanistic and scientific subjects, preferably in the later years of the course.

3. Since a four-year program provides primarily a general foundation training for engineering, a high degree of differentiation of undergraduate curricula by technical or

functional specialties is inadvisable. A primary differentiation according to the major branches of the engineering profession, supplemented by group options in the fourth year, is considered appropriate. There should be little or no differentiation in the first year, and a final choice within groups of closely related curricula should remain open to the end of the second year.

4. A longer undergraduate curriculum may be offered appropriately for students of good general promise who are handicapped by incomplete mathematical and scientific preparation, especially where the engineering colleges are obligated by their public relations to admit such students. In such cases the longer curriculum is supplementary and not a normal program; it does not aim at a higher level of attainment and leads to the bachelor's degree.

Post-Graduate Work.—The Board advises that students who are well above the average in general ability and who purpose to become qualified for creative engineering work should extend their studies through one or more graduate years, leading to a higher degree. Such a program should be decided upon in the upper years of the undergraduate period rather than at its beginning. This additional work may well take one of three forms:

1. An orderly curriculum of advanced studies in engineering technique or administration, in any engineering college well staffed and equipped for engineering instruction on a high professional level.

2. An elective resident program of advanced scientific studies and research in a graduate school; this type of program is appropriate only where notable staff and facilities are provided in both engineering and scientific departments.

3. A program of advanced professional study partly or wholly under industrial auspices, but preferably with organized cooperation between the industry and a graduate school of high rank.

It is advised that a considerable number of the present engineering colleges confine their efforts to a sound under-

graduate program and pursue the practice of directing their graduates to other institutions for advanced work.

CONCLUSION

In conclusion, it seems fitting to outline the Board's conception of the place and function of the engineering colleges in the educational scheme and to indicate some of its ideals for their future progress.

It is the Board's belief that engineering education is so broad in its aims and that its methods are so truly educative as fully to justify its established position as one of the major complete branches of higher education. The engineering college is conceived to be coordinate in organization and status with the college of liberal arts, in both undergraduate and post-graduate divisions. There is a clear-cut distinction, however, in their purposes and their methods of work, which invests the engineering colleges with a professional character. The undergraduate engineering curriculum properly combines humanistic, scientific and technological studies into a coherent and integral program which is set off from a loose grouping of scientific studies by a well-marked professional orientation. The professional element in the curriculum becomes increasingly important in the upper years of the program and dominates the more specialized work of the post-graduate years.

The Board recognizes the need to develop, broaden and enrich engineering education, in view of the constantly enlarging responsibilities of engineers in society and the increasing exactions of professional practice. It holds, however, that this development should proceed from within, by enhancing the distinctive qualities of engineering education, rather than by adding to it unrelated elements from without; that the preservation of a unified program better lends itself to this end; that it is desirable to give a more generous place to distinctly humanistic studies in the curriculum and to give these studies a form and content * which will enrich the student's concep-

* It is the expectation that the Board will deal with the form and content of the humanistic studies of the engineering curriculum in a later section of its reports.

tion of engineering and its place in social economy; that it is desirable to give the student a more connected and better grounding in engineering principles; that a greater effort should be made to develop the student's capacity for self-directed work; and that these ends should be gained, wherever need be, at the expense of unrelated studies on one hand and of detailed technical training on the other. The Board holds that detailed training in engineering technique should be more adequately provided for in both post-graduate and post-scholastic courses.

The Board holds that the principal efforts for the improvement of engineering education must take the direction of a simpler and better balanced curriculum, better selection of students, better qualified teachers, better teaching methods, better subject matters and more adequate provision for advanced training, rather than changes in the scheme of educational organization.

THE ENGINEERING CURRICULUM.*

BY H. P. HAMMOND,

Associate Director of Investigation.

During the investigations of the past three years the problems of engineering education have been studied from a great many standpoints. Such fundamental questions as the general status of the engineering colleges in the field of higher education and the length of the engineering curriculum, for example, have been discussed in the report of the Board of Investigation and Coordination presented in June, 1927. Other fundamental problems such as the selection and admission of students, the post-scholastic education of graduates, and the like have received attention. No matter what the solution of these problems, however, there remain the questions of the actual content of the engineering curriculum and the methods which may best be used in teaching its subjects. It is to the consideration of these immediate problems that the investigation has been directed throughout in considerable measure. An article concerning the Society's summer school which appears elsewhere in this number of the JOURNAL deals with methods of teaching. The present paper is intended to summarize briefly a number of the more significant facts and conclusions concerning the curriculum which have been gathered in the course of the investigation. Some of the material has appeared previously. This has been greatly condensed in the interest of brevity. Other new material has been added. Other than the strictly statistical aspects of curriculum study are discussed; chiefly its structure and the inter-relationship of its parts. The paper concludes with a

* Presented at the 35th annual meeting of the Society for the Promotion of Engineering Education at the University of Maine, Orono, Maine, June 27–30, 1927.

brief discussion of curriculum revision in the light of the various recommendations of the Board.

History and Evolution

Not only the present but the future of engineering education is profoundly influenced by its origins and past development and any study of its problems which fails to consider its historical aspects is likely to lead to erroneous conclusions. It may be well, therefore, to review briefly some points of greatest significance. Two facts of major importance may be noted: one, that engineering education developed from strictly academic origins and not from forms of apprentice training; and the other, that the curriculum of 1849 of the Rensselaer Polytechnic Institute, which was patterned after those of French technical schools, has had a profound effect in shaping others subsequently adopted in this country.

The academic origin of the curriculum has probably been largely responsible for the principle upon which it is organized; that of providing first for the fundamental physical and mathematical sciences and of following them by the applications of the principles of those sciences to the specific problems of engineering. This basic plan is generally regarded as sound, though it has its critics. Dr. Mann, in the report on his studies of engineering education,* questions "the universal habit of teaching first the theory, then the practice," and points out the advantages to be gained through teaching fundamental principles concurrently with their applications. Dr. Flexner, on the other hand, in discussing medical education, points to the organization of the engineering curriculum as an admirable example of the sequence of fundamental sciences and their technical applications. At the present time there seems to be some tendency to introduce more specific engineering training in the early part of the curriculum, but more from the standpoint of the value of such subjects as

* Bulletin Number Eleven of the Carnegie Foundation for the Advancement of Teaching, "A Study of Engineering Education," by Charles Riborg Mann.

means of orienting the student to the engineering viewpoint and method of work than with the idea of teaching fundamental principles by some form of the "case method."

Again from the beginning, and possibly also because of its academic origin, the engineering curriculum has always provided a definite place for the humanistic element. The early curricula included a considerable amount of language study and of history, philosophy, political science, and similar subjects. That such studies have retained a place in engineering education in spite of the demands for the inclusion of more and more technological subjects is recognition of the fact that engineers are believed to need the elements of what is commonly called liberal culture.

The three elements—science, technology and humanistics—have always constituted and still constitute the essential and basic parts of the engineering curriculum. Some of our correspondents believe that a fourth element should be added: *i.e.*, training in the economic aspects of industrial activity and engineering practice. At present the subject of economics is almost always taught rather abstractly and in such a way that it is probably proper to include it among the humanistic subjects. There seems, however, to be a considerable body of opinion that economics should be regarded as one of the basic elements of engineering curricula, having almost as fundamental a place as mathematics and mechanics. If this conception comes to be generally held, if appropriate teaching materials can be assembled, and if suitable methods can be developed for presenting them to engineering students so that they will be led not only to an appreciation of the significance of the economic element in all engineering but also to a command of methods of solving financial and economic phases of their problems, economics may well in time be added as a fourth basic division of engineering study.

Bulletin Number Eleven of the series which presents the results of the investigation gives a clear indication of the more significant evolutionary trends in engineering curricula since 1870, at about which time engineering education began

to make rapid progress in this country and the curriculum to take on substantially its present form. The most striking feature of this evolution until about 1910 or 1915 is a pronounced shift from general to specific training. On the average, about five-eighths of the curriculum of 1870 was devoted to subjects which may be classed as *general,* including the physical and mathematical sciences, English, and humanistic subjects; and about three-eighths to technological subjects. In the period from 1870 to 1915 this proportionate division was reversed. A part of this shift was undoubtedly due to the higher levels of preparation of entering students who, in 1915, offered for admission subjects which were a part of the college program of 1870. A part of this shift was also no doubt due to the wider availability of text books on engineering subjects. But to a considerable extent it was also due to the increasing breadth and diversity of engineering and to advances throughout the field of science. The pressure for the inclusion of more and more technological training forced out of the curriculum a considerable part of the early provision for humanistics.

Although it is more difficult to obtain and interpret the evidence, it is probable that there was a decided increase in the quantitative requirements of engineering curricula. The evidence seems to indicate that curricula of the early years were about equal in content to those in liberal arts. By 1915, the requirements in engineering had come considerably to exceed those in almost all other undergraduate courses. They now require fully the equivalent of five years of work in liberal arts.

Another pronounced trend in engineering curricula in the past fifty years has been an increasing degree of differentiation. The word *specialization* is often applied to this tendency but is here deliberately avoided. What has occurred is the setting up of particular courses of study in the major divisions of engineering and of curricula and options in subdivisions of the major fields. From the single curriculum in civil engineering of the Rensselaer Polytechnic Institute in

1849, the number of curricula and options has increased to a total of eighty-one. A great deal of controversy has centered around this tendency in engineering education. "Specialization" in undergraduate work is quite generally deplored. As a matter of fact there is probably less of specialization than the figures would seem to indicate. While the sub-divisions of engineering curricula are numerous, the degrees of differentiation between curricula is often slight and the content of subject matter common to all curricula is generally large. Furthermore, about nine-tenths of all engineering students are enrolled in the five major curricula and over three-fourths of them in but three—civil, electrical and mechanical engineering. Another point which is usually ignored by the critics of engineering education is that the subdivisions of engineering curricula are in fact no more specialized than the so-called "concentration groups" now in wide vogue in the colleges of liberal arts. Nor are engineering subjects taught from an any more specialized standpoint than are many of the subjects which are so loosely classed as "liberal."

In the last decade or two there seems to be some reaction from the tendency to differentiate courses of study in engineering and a return to a broader and more general type of curriculum. There has been some shift since 1915 away from emphasis upon the specific engineering subjects and slightly more generous provision for the basic sciences and humanities; a movement which appears to be gathering momentum.

Other trends in the content of the curriculum have been the steady decline of modern foreign languages and the increased attention to the study of economics and related subjects such as contract law and accounting.

Objectives of the Curriculum

The objectives of engineering education are disclosed by a study of the curriculum itself. They may be said to be twofold: First to provide the basis of a general education in the field of technology; and second, to give the student a professional discipline and training. These two objectives are not

as distinct as the wording might indicate, but are mutually inclusive to a considerable degree. The field of engineering has become so diversified and includes so many lines of activity that the undergraduate program which is the fundamental basis of preparation for service in it must of necessity be broadly conceived and have a relatively simple objective. However much confusion there may be concerning the relationship of particular parts of the curriculum to the ends sought, the underlying principle seems, nevertheless, to be clearly apparent and to actuate the planning of programs of engineering study.

As above stated, the primary purpose appears to be to provide for the general educational element in the training of engineers. Nearly half of the curriculum is of a general character; it is preparatory to the study of the engineering subjects proper, and would be accepted as partial fulfilment of the requirements for the degree in a college of liberal arts. In many institutions the element of general training extends through the curriculum to the end of the senior year.

At the same time, a strong element of professional training exists in engineering education, not only in the nature of the subjects of the curriculum but also in the methods of approach to those subjects and in the general atmosphere of the engineering college. Engineering students feel themselves to be professional men in the making; in fact, many of them probably have a stronger professional consciousness at the time of graduation than they do subsequently. Robbed of this element or denatured to the extent that they become merely general academic programs with technological leanings, engineering curricula would lose much of their vigor and their appeal to the more purposeful students. It is all very well to regard an engineering education as good preparation for almost any pursuit, and there is no doubt some foundation for that view, but it is highly probable that much of the value of engineering curricula as a general preparation for life rests upon the strong sense of professional status which the student acquires through the progressive concen-

tration of his attention upon professional subjects, and to no small degree upon the sound and rigorous training he receives in them. This point will be dealt with more fully later, but is mentioned here since one of the primary objectives in planning the curriculum is the provision of the professional element throughout the program.

Relationship with Secondary Education

A second factor which is fundamental in the consideration of the curriculum is its relationship with the program of the secondary schools. Engineering education has always been and in all probability will continue to be definitely articulated with secondary education. The beginning level of the curriculum is therefore subject to the limitations imposed by the standards of secondary education.

The element of preparatory training which has the greatest effect in fixing the point of beginning of the important sequences of subjects of engineering curricula is the study of mathematics. Although the median entrance requirement in mathematics is three units, including elementary and intermediate algebra and plane and solid geometry, the median preparation now offered by students is more nearly two and one-half units, since a considerable proportion are admitted with entrance conditions either in solid geometry or the last half-unit of algebra. Trigonometry and higher algebra, while often required, are almost universally given in the first year of the college course. This necessitates providing for elementary mathematics in the freshman year, places calculus in the sophomore year, and generally postpones the major course in mechanics until the junior year.

It would be an immense advantage in planning the undergraduate curriculum if all of the work in pure mathematics (except advanced study by particular groups of students) could be completed by the middle of the second year. This would make it possible to advance the introduction of the major course in mechanics to the latter half of the second year and leave the last two years clear for the applied me-

chanics, technological subjects and humanistics. This condition now obtains in a relatively small number of institutions but is the arrangement recommended in a suggested curriculum which will be presented later.

The other prescribed subjects usually include English, chemistry or physics, history and modern foreign languages. Again it would be a great advantage if these subjects were always presented by entering students and if the training in them, though elementary, were sound and thorough. While physics and chemistry are not absolute essentials as preparation for engineering curricula as they are now commonly arranged, they are highly desirable. The subjects are taken in college by engineering students but the level and pace of the college work are restricted if the student has had no introduction to them.

As far as the nominal level of preparation is concerned, engineering colleges seem content to organize the work of the first year as at present, although this appears actually to involve at least a semester of work which may be regarded as preparatory training.

The serious aspect of the relationship of engineering education to the preparation which precedes it is not, however, so much the extent of the preparation as it is its general character and quality. Two strong tendencies in secondary education contribute to conditions which engineering colleges find to be seriously unsatisfactory. One is the widespread substitution of studies whose purpose is "preparation for citizenship," including civics, other social sciences, and vocational subjects, for those involving more rigorous intellectual training. The other is a general softening of work all along the line. It is futile merely to inveigh against these conditions, yet they present a situation which must be considered, and dealt with if that is possible. There is serious danger that they may cause a general displacement of the curriculum downward. The offering of sub-freshman work in mathematics is very common among the engineering colleges and it would probably be well for many students, in addition to

those now sectioned to sub-freshman groups, to spend at least a semester in mathematical preparation before attempting to carry the regular work of the freshman year. Several institutions are frankly facing this situation and at least one provides a stated curriculum of five years and requires all students to pursue it whose preparation is unsatisfactory, though they present a total of fifteen units for admission. This illustrates what is meant by a displacement of the curriculum downward. None, probably, would want to see all engineering curricula lengthened in this way, yet it would seem better to do something of the sort than to place all students, the ill and the well prepared alike, in the same category. Of course there is always the possibility of refusing admission to those who do not satisfy the entrance requirements, both as to quantity and quality of work, but at present this would mean the rejection of fully one-third of all who apply for admission. Though we dislike to admit it, we are actually as far from anything approaching a satisfactory solution of the admission problem as we ever have been.

Content

Before discussing the possibilities of curriculum revision, which is the ultimate purpose of this report, it may be well briefly to consider existing curricula.

This first requires the selection of a unit of measure. The semester credit-hour which is commonly employed is far from a satisfactory unit and has not been accurately defined or evaluated. As used herein, the credit-hour is intended to represent three clock hours of work on the part of the student. One classroom hour of lectures or recitations, two of exercises requiring written reports, and three of exercises not requiring reports are taken as equal to one credit-hour. In many cases this evaluation is not accurate. The amount of work actually required per credit-hour varies widely between institutions and between subjects in the same institution. A curriculum requiring 125 units for graduation may actually demand more work than one requiring 175. A quan-

titative study of curricula, particularly if comparisons are involved, may therefore be downright misleading in more ways than one. There seems, however, to be no better way in which to study curriculum requirements and the credit-hour is therefore employed.

As shown by the report on the studies of Dr. John of the U. S. Bureau of Education,* the median total requirement for graduation, including physical and military training, is 146 credit-hours, or about 18 per semester. This is equivalent to about 54 hours of work per week on the part of the student, if the basis of evaluation is correct, or about nine hours per day for six days. About thirty hours per week, on the average, are spent in scheduled class work at the college and about 24 hours per week in preparation, an average of four hours per day for six days per week. There is some difference of opinion as to whether or not this load is too heavy. There are some indications that there has been a slight lightening of the load within the past few years and that this is continuing, but the decrease of requirements probably has been slight. One aspect of this matter which some of our correspondents mention is that there are values to be obtained from college education outside of the classroom. With a nine-hour day of actual work, though this does not include all of the demands on the student's time, there is not a great deal of opportunity for him to engage in other activities. Engineering, however, is an exacting profession and arduous work in it is not confined to the part of the engineer's life which he spends in college. Nor is engineering different in this respect from some of the other professions. If the writer may venture his own opinion on this point, he believes that engineering students on the whole at present are not burdened unduly, all things considered. He feels that the fault, if there is one, lies in requiring them to divide their attention and to spread their energies over too many different lines of study at one time and that improvement lies in the direction of concentration on fewer subjects, each of them to be done thoroughly and well, rather than in a general lightening of the load.

* Bulletin Number Ten of the Investigation of Engineering Education.

It is interesting in this connection to note that the requirements in engineering are not in excess of those in certain other curricula; for example, those in architecture and agriculture. The medial graduation requirement in those branches in a number of colleges which were selected for study is about 144 credit-hours; almost exactly the same as in engineering. Bulletin 29, 1924, of the U. S. Bureau of Education gives the median total requirement for graduation of fifty curricula in agriculture as 157 credit-hours. If the credit-hours of these curricula have the same equivalence as in engineering, the graduation requirements are about the same.

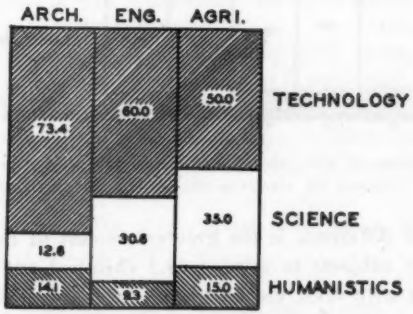

FIG. 1. Comparison of division of curricula into major groups of subjects.

For purposes of a comparison with a suggested curriculum which will be presented later, the division of engineering curricula into three major groups of subjects has been studied. The results show that approximately sixty per cent of the curriculum is devoted to technological subjects, thirty per cent to scientific subjects, and ten per cent to humanistics. It must be remembered, of course, that there is no clear cut distinction between the scientific and technological subjects, but the somewhat arbitrary classification serves quite well as a basis of comparison. Incidentally, it is interesting to compare engineering curricula with those in agriculture and

architecture in respect to this division. This comparison is shown by Fig. 1 which indicates that engineering occupies an intermediate position in its technological requirements between the other two branches.

The figures given above are averages for the five major engineering curricula. There are differences between particular curricula as shown by Fig. 2.

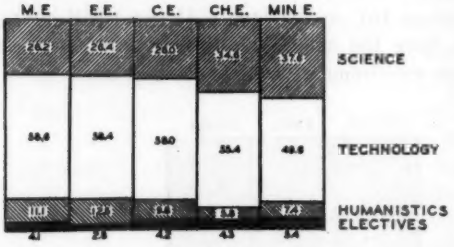

FIG. 2. Division of five principal curricula into major groups of subjects. (Almost all electives are in technological subjects.)

The chief difference is the greater amount of time devoted to scientific subjects in mining and chemical engineering in comparison with civil, electrical and mechanical engineering. This is due to the classification of mineralogy and geology as scientific subjects, in mining engineering, and the greater amount of time devoted to chemistry by chemical engineers. The apparent differences are therefore due to a somewhat arbitrary, but nevertheless, customary, classification of subjects.

These differences have, however, one important significance. They indicate that it is not desirable to continue a curriculum common to all branches so far along in the case of mining engineering and chemical engineering as it is in the other three major divisions. Differentiation of curricula in mining and chemical engineering must begin fairly early if adequate provision is to be made for the sequences of subjects which are characteristic of those divisions.

Also as a basis of comparison with the suggested curriculum which will be discussed later, the division of time between scientific, technological and humanistic subjects in the several years and semesters of the curriculum, is shown by Fig. 3.

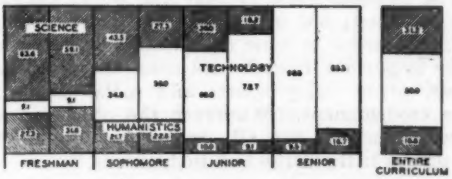

FIG. 3. Division of typical curriculum into major groups of subjects.

The figure indicates the progressive shift from science to technology in a typical curriculum in a particular institution. This curriculum provides for humanistic subjects throughout all four years, the sequence being: English and modern foreign languages, English literature and history, economics, and humanistic electives.

These brief remarks must suffice here for a discussion of the content of the curriculum.

STRUCTURE OF THE CURRICULUM

W. S. Learned, in the Twenty-First Annual Report of the President of the Carnegie Foundation for the Advancement of Teaching, gives the following statement concerning the purposes and methods of college courses, in general, in this country:

". . . The College curriculum is almost self-contained, depending on native intelligence rather than prerequisite training. In most of its earlier courses and in many of its later studies it traverses on a maturer level the ground of the high school below it. Like the latter it has, and under existing circumstances usually can have, no definite aim, or even group of aims. It is a sort of informational department store where the student is invited to shop around and combine any elements that extremely varied motives may suggest, into a

garment of knowledge. If he labors on it for four years, this costume is sanctioned as an education regardless of its shape and, to a very considerable extent, regardless of its quality. One goes to college to prepare to teach in secondary schools, or to satisfy the preliminary requirements for law or medicine, or perhaps even to have the world explained and one's life enriched; but one may, and does, attend quite as comfortably in order to raise or maintain one's social status, or to make important friends and connections of value later in business, or to enjoy sports and social diversions in a distinctive environment. Whatever the object in view, the same process answers for all, just as in the high school; indeed it differs little in the two institutions."

This quotation is given, not so much because it is a discerning criticism of college education in general, as because of the contrast which the picture drawn affords with the aims and methods of engineering education. The writer desires to be understood as not presuming to claim any superior merit for engineering education, but simply to point out that a difference of aims and methods exists which is and should be reflected by a fundamental difference in types of curricula offered. The quotation serves as an introduction to a discussion of the structure of the engineering curriculum, for it is the qualities of definiteness of purpose and organic unity and coherence of internal relationships which so clearly distinguish engineering curricula from general programs of collegiate study.

In order to illustrate what is meant by unity of structure and inter-relationship of parts, a series of charts has been prepared which exhibits the subjects constituting the curricula in three of the major fields of engineering. The subjects shown by the charts were chosen from compilations of opinions of engineering teachers and graduates and a selected number of prominent members of the founder engineering societies; from an extended study of existing curricula; and from other publications of the Board. No attempt is made to indicate the relative importance of the various subjects or the amounts of time devoted to them. Position by years is merely suggested.

Fig. 4 depicts a curriculum in civil engineering. The major sequences of the curriculum are shown beginning with the mathematics of the freshman year. One stem of the curriculum includes physics and advanced mathematics as foundation subjects, passes on through pure and applied mechanics, and leads to the theory of structures, reinforced concrete and structural design. Another branch starting from pure (analytic) mechanics leads through hydraulics to the subjects which are usually grouped together under the

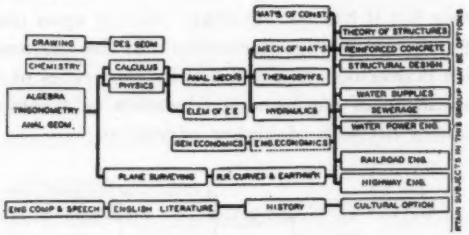

FIG. 4. Relationship and sequence of subjects in civil engineering curricula.

general heading of sanitary and hydraulic engineering. A third stem starts from the mathematics of the first year, includes plane and railroad surveying and leads to railroad and highway engineering. Economics is shown as a foundation subject to the entire group of technological subjects of the latter part of the curriculum, though this is a relationship which can hardly be said actually to exist at present. The humanistic subjects, including English, are shown as a continuous band extending throughout all four years. All of the technological subjects of the latter part of the curriculum are shown as inter-related and dependent upon the training in mathematics, physics and mechanics which precede them.

There are, of course, inter-relationships of subjects which the diagram does not indicate. Surveying, for example, serves as a tool in the execution of all engineering works and is in itself a major advanced subject when carried through its higher phases.

The diagram is intended primarily to exhibit the necessary sequences of subjects which must be carried through continuously from the beginning to the end of the curriculum. The student of structural design must, for example, have acquired a working knowledge of the mechanics of materials, and this in turn must have been preceded by study of mathematics and physics. None of these subjects can be pursued, at least on the level of collegiate work, without grounding in all of those which precede it. This statement contains nothing which is not thoroughly understood by all teachers of engineering but it has an important bearing upon the general status of the engineering curriculum and the engineering college which is overlooked or ignored by the critics of the present organization of engineering education as a complete and self-contained division of higher education.

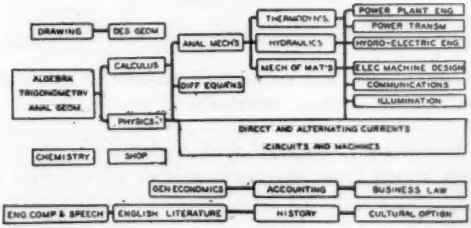

FIG. 5. Relationship and sequence of subjects in electrical engineering curricula.

Fig. 5 is intended to show the sequences, and to a certain extent, the relationships of subjects in electrical engineering. The subjects of the freshman year and many of those of the sophomore year are the same as in civil engineering. The important sequences are indicated. The major courses in direct and alternating current circuits and machines are shown extending throughout the entire second half of the curriculum. The scope of these subjects, which are shown by one block on the diagram, is indicated by the fact that they are sometimes grouped together in catalogues under a

single designation, such as Principles of Electrical Engineering. The other sequences, such as thermodynamics and hydraulics as preparatory subjects to power plant engineering and hydro-electric engineering; and mechanics and mechanics of materials as prerequisites to electrical machine design, are

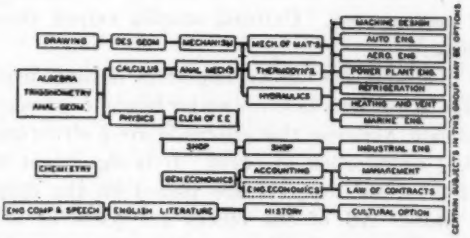

FIG. 6. Relationship and sequence of subjects in mechanical engineering curricula.

also shown. The sequence of economics, engineering economics, accounting and business law reflects the opinions of practicing engineers that all of these subjects should be included in the training of electrical engineers. As in civil engineering, the humanistics are shown as a band extending throughout the curriculum.

Fig. 6 depicts the sequences and relationships of subjects in mechanical engineering and indicates some characteristic differences from civil engineering and electrical engineering. Drawing, descriptive geometry, mechanics and mechanism are shown as a continuous sequence leading to machine design. This division of the mechanical engineering curriculum, if it can be so designated, is the same as one of the principal divisions of the field of mechanical engineering practice—that relating to the designing and construction of machines. A second sequence extends through mathematics, physics, mechanics, thermodynamics and hydraulics and leads to power plant engineering and to the related subjects of refrigeration and heating and ventilation. Aeronautical, automotive and marine engineering (considering the latter as one of the

subdivisions of mechanical engineering) are shown in an intermediate position between machine design and power plant engineering. A third sequence consisting of shop work and industrial engineering is also shown. The element of industrial management in the training and work of mechanical engineers is reflected by the provision of economics, accounting and management. Cultural studies extend through the curriculum.

These diagrams are but an imperfect indication of the relationships of subjects in three major branches of engineering. They indicate, however, that curricula are a structural whole; not a loose aggregation of parts. It is significant that only a very few of the subjects are placed on the diagrams as discrete units. All of the others are parts of continuous sequences and cannot be disarranged in order or relationship without causing serious disruption and making it necessary to provide a longer time to accomplish the same results.

The unitary character of engineering curricula seems clearly, in fact, to be one of their most valuable characteristics; one which supports the claim of engineering education to the validity of its status as a complete, self-contained division of higher education. Subjects of the curriculum follow each other in logical order and the student is led from basic principles, first to general, then to specific applications. Throughout the entire process his knowledge of and ability to deal with the principles of his profession steadily increases. These fundamentals, really comparatively few in number, underlie large portions of the work. Without a grasp of them and an ability to apply them the student cannot, or at least should not, proceed. The admixture of bits of this, that, and the other minor unrelated subject does not add to the value of the curriculum as a whole though each of those subjects may be of value in itself. Concentration upon the major sequences appears to be one of the fundamental principles of curriculum construction.

Differentiation of Curricula

Another feature of the foregoing diagrams, if they are compared with one another, is the essential differences which exist between the major fields of engineering and between appropriate programs of training for them. It is true, of course, that engineering graduates migrate from the field of their college courses and are successful in others; sometimes in ones closely related to their college work, sometimes in ones far removed. Nevertheless it would be just as inappropriate to train students in civil engineering who were expected to become designers of electrical machinery as it would be to expect a graduate of theology to practice as a lawyer. The general method may be the same in the two cases but the subject matter is entirely different. It is true, of course, that there are no clear cut dividing lines between the divisions of engineering. If they were to be depicted as sectors of a circle, the divisions would be better shown as gradations of shading or color than they would by definite dividing lines. Yet the differences of color near the centers of the sectors should be very well marked in order properly to represent essential differences of the principal divisions of engineering. The great diversity of the field of engineering and the many varieties of types of work done by men in any one of its major divisions, together with the fact that for some of these types of work training in one undergraduate program is nearly as appropriate as in another, are likely to obscure the real and fundamental differences which actually do exist between them. There is probably general agreement upon this point in principle, at least by a majority. The difference of opinion is chiefly as to how far the differentiation between courses of study should be carried. The diagrams indicate a moderate, not a slight, degree of divergence beginning early in the curricula and thereafter increasing progressively to the end.

The provision of a common curriculum in the freshman year is now the general practice. This seems to be desirable both because it gives the student one year of work before he

is obliged to choose a particular curriculum and also because there are certain elements of preparatory training (which, incidentally, are included in secondary school programs in European countries) which students of all curricula alike must pursue. The necessity of extended sequences in at least two of the major divisions of engineering, namely, chemical and mining engineering, makes it imperative, unless undue time is to be consumed, to differentiate these curricula from those in electrical, civil and mechanical engineering not later than the beginning of the sophomore year. The sequences to which reference is made are those in chemistry and in mineralogy and geology and the subjects which follow them. Differentiation between civil engineering and electrical and mechanical engineering can come at a somewhat later stage, but it is difficult to make the best arrangements of these curricula if differentiation is deferred much beyond the middle of the second year. Electrical and mechanical engineering have so much in common, however, that it is quite possible to arrange common curricula extending through two full years.

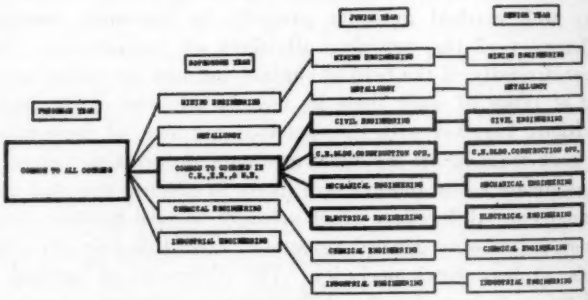

FIG. 7. A diagram of the engineering curricula offered by Yale University.

It should be remembered, of course, that even after differentiation begins, curricula have much subject matter in common. Not until the senior year, is it necessary to have the several curricula largely different throughout.

As an illustration of the differentiation of curricula along the lines just outlined, Fig. 7 is presented which indicates the organization of curricula of the Sheffield Scientific School of Yale University.

A common freshman year is provided at Yale for all students. Mining, metallurgical and chemical engineering differentiate at the beginning of the sophomore year. A curriculum in "engineering science," common to civil, electrical and mechanical engineering, is provided in the second year. After that all curricula are differentiated from each other. This appears to constitute the "moderate" degree of differentiation which our correspondents favor. The organization of the Yale curriculum is interesting from another standpoint since, beginning with the sophomore year, it provides what is virtually a *functional* type of differentiation through the inclusion of a course in industrial engineering.

Existing curricula differ greatly in the actual content of common subject matter provided in the various years and semesters. It was not found possible to make any accurate and comprehensive tabulation to show this, but an approximate analysis indicates that about the following percentages of common content are generally provided in civil, electrical and mechanical engineering:

First year	100%
Second year	60% to 75%
Third year	40% to 60%
Fourth year	10% to 25%

The figures for the last two years depend to a considerable extent upon the time allotted to humanistic subjects and to economics, contract law, and accounting.

Curricula in chemical and mining engineering have less content in common with the others. The figures are about as follows:

First year	100%
Second year	40% to 50%
Third year	20% to 30%
Fourth year	0 to 25%

The schematic curricula which will be discussed presently indicate the percentages of common subject matter which, we believe, can be appropriately provided.

Post-Graduate Programs

Discussion of the curriculum would be incomplete without reference to post-graduate work in engineering, both because of the extent of present provisions for advanced study and because more adequate provisions seem to be one of the most desirable developments in engineering education.

The amount of post-graduate work done in engineering is often underestimated. In 1925–26 there were over 1,100 graduate students of engineering enrolled. This is about one-eighth the number of first degrees conferred in engineering in the preceding year. Eighty-one, or slightly more than one-half of the one hundred fifty odd, engineering colleges provide for graduate work and practically all of them have graduate students enrolled. These figures do not accurately picture the situation however, unless it is added that over three-fourths of the entire enrollment is in ten institutions, and that over twenty per cent is in one of them. About seven-eighths of the registration is in the five major branches, the balance being scattered through a considerable range of special curricula. It must be remembered, however, that while graduate students are for the most part enrolled in the major curricula, the lines of work which they pursue are actually greatly diversified. Very often such students concentrate in some particular field of specialization.

The development of graduate work in engineering is probably the logical outcome of the crowding of undergraduate curricula which has been characteristic of the past two or three decades. More and more it is realized that a limited objective should be set for the undergraduate program and that more advanced training either in or out of college is needed to complete preparation for the more advanced and technical phases of engineering work.

Types of graduate programs differ widely; in fact, this is

true of the entire regime and character of the work done. It is impossible definitely to classify the programs as to type but they appear to fall into three main groups. One may be said to be in the nature of an extension of the type and regime of work of the latter part of the undergraduate program. The studies are just as strictly of an engineering character as are those of the senior year and the students work under fairly close supervision. In another type of program the work is considerably more scientific in character and less directly related to engineering. Such programs are frequently provided by the graduate schools of the universities and the student is sometimes only nominally under the direction of the engineering faculty. The third type of post-graduate, or more accurately—the post-scholastic, work is provided by the training programs of industrial firms. The speaker does not include here the so-called "cadet courses" of the large manufacturing firms, but rather the organized programs of study pursued by employees on a part-time basis under regular instruction.

The Board, in its report of June, 1927, recognizes and advocates the validity of a rather clear cut distinction between undergraduate and post-graduate work in engineering and recommends that the normal undergraduate course be considered as a terminal program leading to a degree, the advanced work being pursued at the student's option. This, as a matter of fact, is the present condition. It appears to be the normal one and the enhancement of engineering education through better provisions for more advanced training would seem to lie in a further extension of the types of programs now offered rather than in a lengthening of the undergraduate curriculum or a change in the type of organization of the engineering college.

Curriculum Revision

It has not been the purpose in the present investigation to present a definitely recommended curriculum, but rather to furnish the important facts concerning existing curricula and

their origins and development, and to gather and disseminate the opinions of all those concerned or interested in the curriculum and its results. It is also the purpose to stimulate the faculties themselves to examine their courses of study in the light of all the facts and the basic, not specific, recommendations which have developed out of them, in the hope that each faculty will study its curriculum and make such revisions as appear desirable in the light of local conditions.

TABLE 1.

SCHEMATIC CURRICULUM.

INTRODUCTORY STAGE, 2 YEARS.

FIRST YEAR, in Common:	Semester First.	Credits Second.
Mathematics	5	5
Inorganic Chemistry	4	4
Graphics	3	3
English	3	3
Shop or Surveying*	2	2*

* Option in second semester.

SECOND YEAR:	CIVIL.		ELEC-TRICAL.		ME-CHAN-ICAL.		CHEM-ICAL.		MINING.	
Mathematics	4	4	4	4	4	4	4	4	4	4
Physics	5	5	5	5	5	5	5	5	5	5
Chemistry							4	4	4	
Geology										4
Economics	3	3	3	3	3	3	3	3	3	3
Mechanism and Design			4		4					
Surveying and Plotting	4									
Mechanics		4		4		4				
Lab. Technology or Eng. Problems	1	1	1	1	1	1	1	1	1	1

REQUIRED SUMMER TERM, 4 TO 6 WEEKS:

Surveying ..... Civil Engineering Curriculum
Shopwork ..... Mechanical Engineering Curriculum
Introd. Elec. Eng. ..... Electrical Engineering Curriculum
Introd. Chem. Eng. ..... Chemical Engineering Curriculum
Mine Surv. (2), Geol. and Mineral. (4)
Mining Engineering Curriculum

TABLE I, *Continued.*

ADVANCED STAGE, 2 YEARS.

THIRD YEAR:	CIVIL.		ELEC-TRICAL.		ME-CHAN-ICAL.		CHEM-ICAL.		MIN-ING.	
Math., Phys., Chem., Biol. or Geol.	3		3		3		†	†	3	3
English or For. Language	3	3	3	3	3	3	3	3	3	3
Mechanics and Materials	4	4	4	4	4	4	4	4	4	4
Hydraulics		4.5					2			
Heat Power	4.5		3	4.5	†	†	3	4.5	4.5	
Electric Power			†	†	3	4.5				
Major Eng. Subject	2.5	5.5	4	5.5	4	5.5	5	5.5	2.5	7.0
FOURTH YEAR:										
For. Lang., Hist. and Gov., or other general studies	3	3	3	3	3	3	3	3	3	3
Electric Power	4.5		†	†			4.5		4.5	
Hydraulics			4		4				2	
Major Eng. and Adm. Subj's (group options)	9.5	14	10	14	10	14	9.5	14	7.5	14

† Included in major engineering subject.

OPTIONAL GRADUATE YEAR.

Science or Economics	4 to 6	4 to 6
General non-technical study	0 to 3	0 to 3
Engineering and administrative subjects and research	13 to 9	13 to 9

As a basis for study and discussion rather than as specific recommendations a group of curricula have been prepared and presented by the Director. They were published in the April, 1927, number of the JOURNAL. These curricula are based upon the recommendations of the Board as given in its Preliminary Report of November, 1926, and are prepared chiefly as examples of how those recommendations may be incorporated into actual courses of study.

They are reproduced here as a conclusion to this paper in order to indicate the general directions and ends toward which the study of the curriculum has led.

The various features of these schematic curricula were discussed in the publication mentioned above. To that discussion the following is added:

(1) The proportionate division of the time allotments of the various subjects when classified in three major groups, sciences, technology and humanistics, is as shown by Fig. 8

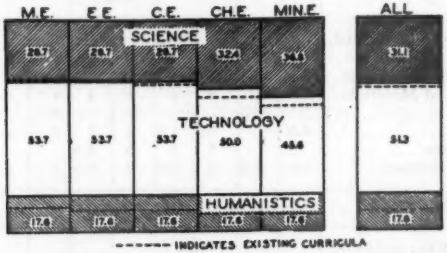

FIG. 8. Division of five proposed curricula into major groups of subjects.

and Table 2. Figures in parentheses in Table 2 are for existing curricula. Those not in parentheses are for the proposed curricula.

TABLE 2.

	Humanistic.	Scientific.	Technological.
Civil Engineering	17.6% (10.5%)	28.7% (30.0%)	53.7% (59.5%)
Electrical Engineering	17.6% (10.4%)	28.7% (28.6%)	53.7% (61.0%)
Mechanical Engineering	17.6% (11.5%)	28.7% (27.4%)	53.7% (61.1%)
Chemical Engineering	17.6% (8.3%)	32.4% (26.1%)	50.0% (55.6%)
Mining Engineering	17.6% (8.0%)	36.8% (40.9%)	45.6% (51.1%)

The greater provision for science in chemical and mining engineering is more apparent than real and is due to the classification of certain courses in chemistry and geology, mineralogy and metallurgy among the sciences rather than among the technological subjects.

(2) The proportionate division of the curriculum into the

same three major groups of subjects during the several years is shown by Fig. 9.

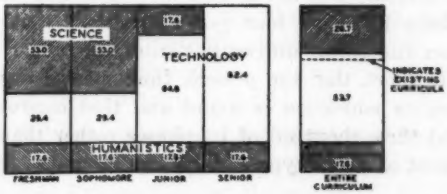

FIG. 9. Division of proposed curriculum into major groups of subjects.

(3) The following tabulation gives the figures which indicate the progressive differentiation of curricula:

	Content of Subject Matter Common to All Curricula.
First year	100.0%
Second year	76.5%
Third year	40.1%
Fourth year	23.5%

The suggested curricula exhibit the following significant differences from those now in effect:

(*a*) A decrease from a present median of 146 to a proposed median of 140 credit-hours.

(*b*) A smaller number of subjects to be pursued at one time. The maximum number during the first three years is five. In the senior year the number depends upon the particular arrangements in presenting the technological subjects in the field of specialization but in any event a maximum of six is recommended.

(*c*) More generous provision for the humanistic subjects at the expense of the technological subjects.

(*d*) In general, less differentiation between curricula and a larger content of subjects common to all.

These curricula and the recommendations which they embody are based upon the assumptions that engineering education will continue as at present to be one of the major divi-

sions of higher education, that the basic curricula will be undergraduate in character articulating with the work of secondary schools, that the normal undergraduate curriculum will continue to be of four years duration, that technical rather than functional differentiation of the major curricula is valid; in short, that the present fundamental organization of engineering education is sound and that improvement is best sought throughout all of its phases rather than through establishment of a new type of organization and program.

PROGRAM OF THE THIRTY-FIFTH ANNUAL MEETING, UNIVERSITY OF MAINE, ORONO, MAINE, JUNE 27–30, 1927.

MONDAY, JUNE 27, 1927.

10:00 A.M. Joint meeting of the Division of Deans and Administrative Officers and Teachers of English, Aubert Hall. J. Raleigh Nelson, University of Michigan, presiding.

Subject: The Teacher of English in the College of Engineering.

12:30 P.M. Luncheon meeting of the Council. Mt. Vernon House.

2:00 P.M. Opening Session, Alumni Hall.

O. M. Leland, President, presiding.

Address of Welcome. H. S. Boardman, President, The University of Maine.

Response: O. M. Leland, President of the Society.

A Study of the Learning Process. D. D. Curtis, The Iowa State University.

Modern Educational Tendencies as Affecting the Preparation of Engineering Students. E. H. Comstock, University of Minnesota.

Psychological Factors Involved in the Presentation of Class Material. C. A. Dickinson, University of Maine.

Teachers of Freshmen. C. V. Mann, Missouri School of Mines.

Discussion of Papers.

4:30 P.M. Adjournment.

8:00 P.M. General Good-Fellowship Meeting, Alumni Hall. (Ladies invited.)

Dancing.

TUESDAY, JUNE 28, 1927.

7:30 A.M. Breakfast Meeting of the Council, Mt. Vernon House.

9:30 A.M. Second Session, Alumni Hall.
O. M. Leland, President, presiding.
The Report of the Board of Investigation and Coordination:
Charles F. Scott, Chairman,
W. E. Wickenden, Director of Investigations,
H. P. Hammond, Associate Director of Investigations.
Discussion.

12:00 M. Luncheon and Conference of Teachers of English.

2:00 P.M. Third Session, Alumni Hall.
O. M. Leland, President, presiding.
Report of the Board of Investigation and Coordination, Continued.
Discussion.

5:00 P.M. President and Mrs. H. S. Boardman, "At Home," President's House, Campus.

8:00 P.M. Round Table, Alumni Hall.
Paul Cloke, University of Maine, presiding.

WEDNESDAY, JUNE 29, 1927.

9:30 A.M. Meeting of the Division of Deans and Administrative Officers, Alumni Hall.
M. S. Ketchum, University of Illinois, Chairman, presiding.
Graduate Work:
G. M. Butler, University of Arizona.
D. C. Jackson, Massachusetts Institute of Technology.
C. S. Coler, Westinghouse E. & M. Company.
Discussion.

9:30 A.M. Conference on Drawing and Design, Wingate Hall, T. E. French, The Ohio State University, presiding.

9:30 A.M. Conference on Orientation and Engineering Problems Courses, Wingate Hall.
F. C. Dana, The Iowa State College, presiding.

9:30 A.M. Conference on English, Building of Arts and Sciences. J. Raleigh Nelson, University of Michigan, presiding.
Subject: Making English an Integral Part of the Engineering Curriculum.

Miss Sada Harbarger of Ohio State will present her report on The Status of Freshman Composition in the Engineering Colleges.

11:30 A.M. Fourth Session, Alumni Hall.
O. M. Leland, President, presiding.
Report of Committees.
Report of the Secretary.
Report of the Treasurer.

1:00 P.M. Luncheon and visit at Lucerne in Maine.

7:00 P.M. Annual Dinner, Gymnasium.
W. S. Rodman, Vice-President, presiding.
Presidential Address: Are We Making Progress? O. M. Leland, Dean, College of Engineering and Architecture, and the School of Chemistry, University of Minnesota.
Movies and Music.

THURSDAY, JUNE 30, 1927.

7:30 A.M. Breakfast Meeting of the Council. Mt. Vernon House.

9:30 A.M. Fifth Session, Alumni Hall.
O. M. Leland, President, presiding.
The Engineer in his Public and Civic Relationship. Paul Cloke, University of Maine.
Cooperative Courses at the Massachusetts Institute of Technology. W. H. Timbie.
Discussion: F. E. Ayer, Municipal University of Akron.
The Problem of Engineering Education and the Small College. H. W. McKiel, Mount Allison University.
Adult Education in Concrete Technology. W. K. Hatt, Purdue University.
Relation of Economics to the Work of the Engineer, J. A. Ashworth, University of Maine.
Discussion.
Reports of Committees.
Adjournment.

1:00 P.M. Trip to Bar Harbor and Shore Dinner or Trip to Moosehead Lake with steamboat ride.

Local Committees.

Registration.

E. H. Sprague, Chairman
E. J. Felker C. E. Hart
H. W. Leavitt

Information.

W. J. Creamer, Jr., Chairman
K. G. Crabtree C. Otto
E. L. Roberts

Housing.

W. S. Evans, Chairman A. C. Lyon

Entertainment.

C. A. Brautlecht, Chairman
B. F. Brann P. D. Bray

Meetings.

W. E. Barrows, Chairman
H. R. Perkins E. W. Davee
A. S. Hill H. C. White

Dinner.

B. C. Kent, Chairman G. H. Reid

Publicity and Printing.

C. P. Weston, Chairman
C. A. Sherer T. A. Sparrow

Reception and Transportation.

W. J. Sweetser, Chairman
A. O. Willey T. Eckert
H. D. Watson L. C. Jenness
J. G. L. Caulfield

Finance.

F. S. Young, Chairman E. H. Kelley

Ladies.

Mrs. Cloke, Chairman	Mrs. Bray
Mrs. Barrows	Mrs. Evans
Mrs. Sweetser	Mrs. Watson
Mrs. Brautlecht	Mrs. Roberts
Mrs. Sprague	Mrs. Davee
Mrs. Kent	Mrs. Felker
Mrs. Hill	Mrs. Perkins
Mrs. Lyon	Mrs. Jenness
Mrs. Brann	Miss Perkins
Mrs. Leavitt	Mrs. Crabtree

Mrs. Sparrow

MINUTES OF THE MEETINGS OF THE COUNCIL HELD AT THE UNIVERSITY OF MAINE, ORONO, MAINE, JUNE 27–30, 1927.

Meetings were held in the Mt. Vernon House on the campus.

Present: President O. M. Leland, presiding, G. C. Anthony, F. L. Bishop, H. S. Boardman, Paul Cloke, S. B. Earle, T. E. French, A. M. Greene, Jr., G. M. Braune, H. P. Hammond, Sada A. Harbarger, E. R. Hedrick, H. H. Jordan, W. H. Kenerson, M. S. Ketchum, A. C. Lanier, C. M. McKergow, C. E. Magnusson, W. T. Magruder, G. B. Pegram, A. A. Potter, D. B. Prentice, R. I. Rees, W. S. Rodman, R. L. Sackett, C. F. Scott, R. A Seaton, A. N. Talbot, F. E. Turneaure, J. W. Votey, W. E. Wickenden.

The Committee on Change of Name of the Society recommended that the name of the Society for the Promotion of Engineering Education remain the same. Recommendation accepted.

The Committee on the Lamme Medal reported progress in securing the proper design for a medal. The Executive Committee of the Society was instructed to draw up a trust agreement, in accordance with the will of Mr. Lamme, so if the Society should cease to exist there will be designated a group of persons to determine the organization to take over the fund. It was suggested that the District U. S. Judge of Western Pennsylvania, the President of the Ohio State University, and the Dean of Engineering at the Ohio State University be the persons named.

Invitations from the Ohio State University, the University of Wisconsin and the Asheville Chamber of Commerce, representing the University of North Carolina, were received to hold the 1928 meeting. Upon motion the Council accepted the invitation of the Ohio State University. (The date to be determined later.)

The Chairman of the Committee on Mathematics asked the

Council to instruct him as to how far the work of that committee might extend. He was instructed to take the work up in a serious manner and request the cooperation of committees in each institution acting through the Board of Investigation and Coordination and the Director of Investigations. The syllabus is to include a syllabus on high school mathematics.

The auditor's report of the accounts of the Treasurer was read and accepted.

A motion was made that the expenses of the Secretary and of the Assistant Secretary in attending the regular meetings of the Society be paid and that this action be effective as of June 1, 1927.

A motion was made that $1.00 assessment be levied on all members for the year 1927–28.

A motion was made that we cooperate in every possible way and express our approval of the plans of the Peaceful Arts Museum.

The Committee on Policy presented the following report, which was accepted and the Chairman instructed to present the plan to the Society for its endorsement.

A.

The Society, as organized, has two distinct classes of membership, individual and institutional. In theory, the institutional members have been represented by delegates. In fact, although there was for years a meeting of institutional delegates annually, it was ineffective as really representing institutional interests. To represent better those interests there was formed the Division of Deans and Administrative Officers. This has functioned effectively in many ways but in its name and its organization does not yet fully meet the requirements of real representation for the institutional members.

Your Committee therefore recommends:

1. That the institutional members be constituted the Institutional Division of the Society and that the present Division of Deans and Administrative Officers be merged into this new Division.

2. That it be the function of the Institutional Division of the Society to concern itself with matters of primary interest to institutions or schools as such; for example, such matters as the recognition of degrees and other credentials, admission requirements and procedures, personnel systems, cost and fees, teacher training in summer schools and otherwise, coordination of scholastic and post-scholastic education.

3. That representation in the Institutional Division be through one or more delegates appointed severally by the Institutional members and that all voting in this Division be by institutions, one vote to each institutional member, to be cast by its accredited delegate or delegates.

4. That one of the two vice-presidents of the Society be designated by the President to act as chairman of the Institutional Division.

B.

The work of the Board of Investigation and Coordination which will soon be brought to a close has demonstrated that the faculties of engineering schools can cooperate with great effectiveness in the study of problems of engineering education when aided and guided by a central directing board and staff. If engineering education is to progress, study of its problems must continue by individuals, faculties, by this Society and by others, but our recent experience makes very clear that the best results can be obtained, and obtained most economically in the long run, by concerted action through a central agency. There are, of course, many problems that can be studied by individual teachers, by local groups, and by committees of this Society. The efficient administration of these studies calls for more aid through a central staff than the regular income of this Society can support. But there are other subjects of the greatest significance to engineering involving relations with the professional societies and with industry which can hardly be developed at all except through a well-supported staff for research and publication; such subjects as a general development policy for engineering education, cooperation in educational achievement outside of regu-

lar scholastic processes, promotion of public interest in engineering education, cultivation of international relations and reciprocity.

When fully worked out such a central organization would appear to call for

1. A Board of Direction.
2. A permanent research and clerical staff and experts on special appointment.
3. A joint liaison board with representation from this Society, from the professional engineering societies, and from industry through some of its recognized channels.
4. An endowed Foundation for Engineering Education to receive, hold, and administer trust funds and to employ the income through this Society for the advancement of engineering education in ways that supplement the activities of the individual engineering schools and colleges.

It is therefore recommended:

That steps be taken to provide for an adequate central staff to engage in research in engineering education, to afford general information in regard to engineering education, and to correlate the activities of this Society with the interests of engineering profession, of industry, and of the general public.

To make possible such a program, it is further recommended:

That the Society seek at once to obtain support to the amount of not less than $30,000 a year for the maintenance of this instrument of educational research, information, and advancement, preferably in the form of a permanently endowed foundation.

Committee on Policy:
F. L. BISHOP,
H. S. BOARDMAN,
A. A. POTTER,
C. F. SCOTT,
G. B. PEGRAM, *Chairman.*
(John G. Bowman unable to attend.)

A motion was made that a Committee on Ways and Means shall be appointed by the President, the President-Elect, and the Secretary of the Society, and that Charles F. Scott and the new President be members of the Committee. The following Committee was appointed:

A. A. Potter, *Chairman,*
Charles F. Scott,
R. L. Sackett,
W. E. Wickenden,
F. L. Bishop.

The following report of the Committee on Policy was accepted:

There was referred to the Committee on Policy the consideration of the interests of the Society in the cooperative method of engineering education and the significance to the Society of the recently organized Association of Cooperative Colleges. Through correspondence with Dean Herman Schneider and through conversation at this Orono meeting with Dean F. E. Ayer of Akron, who comes directly from the meeting of directors of the Association of Cooperative Colleges with special appointment by those directors to confer with this Committee, the following seems to be the situation:

The Association of Cooperative Colleges meant to be an association inclusive of all cooperative schools, not simply those in engineering. At the present time of the twenty-five or more schools represented, about two-thirds are schools of engineering, but Dean Ayer says that he thinks the preponderance of engineering schools will, in the future, not be so great. Schools of commerce and business are taking up the cooperative method and there is one theological school represented in the Association.

Since up to the present most of the work under the cooperative method has been in the field of engineering, the interests of the Association are closely allied in the personnel of its membership with those of engineering schools and at its recent meeting the directors of the Association took action looking toward having the annual meeting of the Association im-

mediately before or immediately after the next S. P. E. E. meeting and at the same place. It is gathered that the Association had not considered that its work will either interfere or be a substitute for the work that the Society for the Promotion of Engineering Education can and should do on the subject of cooperative methods in engineering schools.

Your Committee on Policy would therefore propose that the Council authorize the appointment of a standing committee of this Society on the Cooperative Method in Engineering Education.

(In this connection it was the suggestion of Dean Ayer that if such a committee be appointed it would be desirable to have its membership made up partly of those directly engaged in the application of the cooperative method and partly of those not so engaged.)

The Committee on Policy was requested to consider the desirability of the establishment of a Division of Non-Collegiate Technical and Trade Schools and to report its recommendations to the Council in 1928. Likewise, its recommendation as to whether the grade of institutional member should be extended to such schools and to public high schools.

The Committee on Policy was requested to consider, recommend, and report to the Council in 1928 what kinds, types, and grades of colleges, institutes and schools shall be elected as institutional members with possible proposals for changes in Article II of the Constitution.

The perpetuation of the Committee on Policy was referred to that committee to report in 1928.

It was the sense of the Council that it is not the policy of the Society to maintain membership in other organizations which involve financial obligations.

It was the sense of the Council that the matter of the Freeman Travelling Scholarship in Hydraulics of the A. S. M. E. be presented to the meeting for the information of the members.

The Chairman of the Board of Investigation and Coordina-

tion presented the report of that Board for the year. The report was accepted.

The Board of Investigation and Coordination recommended to the Council for its confirmation the reappointment of D. C. Jackson as a member of the Board for a term of five years. Council confirmed this appointment.

The Council took action instructing the Secretary to extend to Alfred D. Flynn, Director of Engineering Foundation, our thanks and appreciation for his active cooperation with the Fund Committee of the Board of Investigation and Coordination in the raising of funds for continuing the work of the Board for the present two-year period; also that our appreciation be expressed to the contributors to the fund and that the Secretary send appropriate letters.

The Council authorized the establishment of the Greater New York-Northern New Jersey Section of the Society.

The Council sanctioned a regional conference in the southeastern part of the country as an action of the Society.

An invitation was extended to the members of the Council to visit the two summer schools at Wisconsin and at Cornell.

The following budget was adopted for 1927–28:

Receipts:		
Individual dues (1500 at $5)		$ 7,500.00
Institutional dues (120 at $10)		1,200.00
Back dues		500.00
Advertising		2,000.00
Sale of publications		250.00
		$11,450.00
Disbursements:		
A. 1928 Meeting	$ 600.00	
C. Journal, Proceedings, year book	5,500.00	
D. Committee Expenses	150.00	
F. Secretary's honorarium	1,000.00	
H. Clerical assistance	2,600.00	
I. Sundry printing	300.00	
J. Postage	200.00	
K. Telegraph and telephone	50.00	
L. Supplies	50.00	10,350.00
Estimated surplus		$ 1,000.00

A motion was passed that $500.00 be added to the above budget for contingencies. This would make the estimated surplus $500.00.

A vote of thanks was extended to the hostess of the Mt. Vernon House for the use of the room for the meetings of the Council and for the excellent meals served.

Respectfully submitted,

F. L. BISHOP,
Secretary.

MINUTES OF THE THIRTY–FIFTH ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, UNIVERSITY OF MAINE, ORONO, MAINE, JUNE 27 TO JUNE 30, 1927.

The thirty-fifth annual meeting of the Society for the Promotion of Engineering Education was held at the University of Maine, Orono, Maine, Monday, June 27, to Thursday, June 30, 1927, inclusive. The meetings were held in Alumni Hall. The President of the Society, O. M. Leland, Dean of the College of Engineering and Architecture, and the School of Chemistry, University of Minnesota, presided. There were 440 members and guests registered.

At 10 A.M., Monday, June 27, in Aubert Hall, the sixth joint meeting of the Division of Deans and Administrative Officers and teachers of English was held. Professor J. Raleigh Nelson, Chairman of the Committee on English, presided. The subject discussed at this meeting was "The Teacher of English in the Colleges of Engineering." A report of this meeting will be published in a later number of the JOURNAL.

MONDAY, JUNE 27, 1927, 2:00 P.M.

The thirty-fifth annual meeting of the Society was opened at 2:00 P.M., in Alumni Hall by O. M. Leland, President of the Society. President Leland introduced H. S. Boardman, President of the University of Maine who welcomed the Society to the University. He presented to the President of the Society a gavel which was made from State of Maine hardwood and the wood was colored while growing. President Leland responded to the address of welcome on behalf of the Society. He also accepted the "symbol of authority" from the University and expressed his great pleasure in receiving such a gift.

D. D. Curtis, The Iowa State University, read his paper on

"A Study of the Learning Process." E. M. Comstock, University of Minnesota, presented his paper "Modern Educational Tendencies as Effecting the Preparation of Engineering Students." C. A. Dickinson, University of Maine, read his paper on "Psychological Factors Involved in the Presentation of Class Material." These papers were then discussed.

The President appointed a Committee on Resolutions consisting of H. S. Evans, Colorado, *Chairman*, Louis Mitchell, Syracuse, A. C. Lanier, Missouri, C. M. McKergow, Toronto, and J. C. Clark, Arizona.

Tuesday, June 28, 1927, Second Session.

The second session of the convention was called to order at 9:30 A.M. by President Leland. Dean G. B. Pegram presented a bunch of carnations to the President with the congratulations of all the members of the Society on the successful completion of "the first year of his second fifty."

The second and the third sessions were devoted to the work of the Board of Investigation and Coordination presented by the Chairman, Charles F. Scott, the Director, W. E. Wickenden, and the Associate Director, H. P. Hammond. Discussion.

The third session was held on the lawn in front of Alumni Hall, which was a natural amphitheater. This proved very satisfactory. The next day was cooler and the meetings were held in Alumni Hall.

Wednesday, June 29, 1927, Fourth Session.

The fourth session of the convention was called to order at 11:30 A.M. by President Leland, the earlier part of the day being devoted to a meeting of the Division of Deans and Administrative Officers; a conference of Teachers of English; and a conference on Orientation and Engineering Problems.

The Committee on Nominations presented the following report. Upon motion the Secretary cast the unanimous ballot for all officers named:

For President:

R. L. Sackett, The Pennsylvania State College, State College, Pa.

For Vice-Presidents:

C. E. Magnusson, University of Washington, Seattle, Wash.

T. E. French, The Ohio State University, Columbus, Ohio.

For Secretary:

F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

For Treasurer:

W. O. Wiley, John Wiley & Sons, New York City.

For Members of the Council:

J. M. Bryant, University of Texas, Austin, Texas.

S. B. Earle, Clemson College, Clemson College, S. C.

S. S. Edmands, Pratt Institute, Brooklyn, N. Y.

H. P. Hammond, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

A. C. Lanier, University of Missouri, Columbia, Mo.

C. M. McKergow, McGill University, Montreal, Canada.

D. B. Prentice, Lafayette College, Easton, Pa.

The oldest and the youngest Past President, from point of service, in attendance at the meeting, A. N. Talbot and G. B. Pegram, respectively, escorted the newly elected president, R. L. Sackett, to the platform where he was greeted by President Leland. President-Elect Sackett expressed his appreciation of the honor conferred upon him and asked the members to assist him during the coming year "in bringing to a logical conclusion this movement into which the Board and the investigating authorities have put their souls."

The report of the Secretary was read by title, accepted and ordered printed.

In the absence of the Treasurer, W. O. Wiley, who was in Europe, the Secretary read the report which the auditor had prepared. This report was accepted and ordered printed.

The afternoon was given over to a luncheon and a visit to Lucerne in Maine.

WEDNESDAY, JUNE 29, 1927, 7 P.M.

The annual dinner of the Society was held in the Gymnasium at 7:00 P.M. Vice-President W. S. Rodman presided. The presidential address "Are We Making Progress?" was delivered by O. M. Leland, Dean, College of Engineering and Architecture and the School of Chemistry, University of Minnesota. At its conclusion Ralph O. Brewster, Governor of the State of Maine, spoke informally on the value of the engineer to the community. Dancing followed.

THURSDAY, JUNE 30, 1927, FIFTH SESSION.

The fifth session was opened at 9:30 A.M. by President Leland. W. H. Timbie read his paper on "Cooperative Courses at the Massachusetts Institute of Technology." Paul Cloke, University of Maine, presented a paper on "Teachers of Freshmen." These papers were then discussed. In the absence of W. K. Hatt, Purdue University, his paper, "Adult Education in Concrete Technology," was read by title. H. A. Ashworth, University of Maine, read his paper "The Relation of Economics to the Work of the Engineer," and H. W. McKiel, Mount Allison University, read his paper "The Problem of Engineering Education and the Smaller College." Discussion.

The President reported the following actions of the Council of the Society:

The 1928 meeting of the Society would be held at The Ohio State University, Columbus, Ohio, the time to be decided later.

A standing committee on cooperative methods in schools had been provided.

The Division of Deans and Administrative Officers had been merged in the new Division of Institutional Members. One of the vice-presidents will be chairman of this Division.

A plan had been adopted for providing a permanent central staff and that the Society seek to obtain adequate support for this work preferably in the form of a permanent endowment which would yield approximately $30,000 per year.

These recommendations were formally adopted by the Society.

The Society approved the report of the Sectional Committee of the American Engineering Standards Committee on Mathematical Symbols. (These symbols have been published in the JOURNAL of the Society.)

The report of the Committee on Chemical Engineering was read and approved. The report of the Committee on Orientation and Engineering Problems Courses was read and approved. The report of the Committee on English was read and approved. The report of the Committee on Resolutions was read and carried by a rising vote. They were ordered spread on the minutes of the meeting.

Your Committee on Resolutions at the close of this convention, the largest in the history of the Society, find themselves at a loss to express adequately the appreciation felt by our members and guests in attendance, for the innumerable courtesies extended by the University of Maine, its convention committees, and other organizations of the community and State, all of which have been extended to us with such a fine spirit of hospitality.

In an attempt to express this appreciation be it therefore,

Resolved: That the sincere thanks of the Society for the Promotion of Engineering Education be expressed to President Boardman of the University of Maine who for many years past has been one of our active and valued members, to the Governing Board of the University, and to the Dean and Faculty of the Engineering College, for their cordial hospitality and successful efforts in making the University of Maine meeting one to be long remembered by all who have had the good fortune to be in attendance;

To President and Mrs. Boardman for the hospitality extended us in the delightful reception at their home;

To the Local Committees for their careful and well executed plans for our meetings and our entertainment;

To the Local Committee of Ladies for their hospitality to and thoughtful consideration of the ladies of the convention, and the delightful entertainment afforded them, and also for the special arrangements and care for the younger visiting members;

To the Penobscot Valley Country Club for courtesies extended to our members and guests;

To the State Highway Police who for our convenience and safety have acted as our guides and escorts; and

To Governor Brewster for his consideration in attending our annual dinner and for his delightful and inspirational address.

And be it further *Resolved:* That the thanks of the Society as a whole and especially of those members and guests who were able to avail themselves of this unusual feature of the convention be extended to Dean J. W. Votey; to the University of Vermont; and to the Rotary Club of St. Johnsbury, for the carefully planned and very interesting and enjoyable caravan journey from Burlington, Vermont, to Orono, Maine.

H. S. Evans,
Louis Mitchell,
A. C. Lanier,
C. M. McKergow,
J. C. Clark.

The following applicants were elected to membership in the Society:

Atkinson, Albert A., Professor of Physics and Electrical Engineering, Ohio University, Athens, Ohio. Sponsors, F. C. Caldwell, J. E. Shepardson.

Buchanan, Jesse E., Instructor in Civil Engineering, University of Idaho, Moscow, Idaho. Sponsors, I. C. Crawford, I. N. Carter.

Costa, John J., Professor of Civil Engineering, Manhattan College, New York City. Sponsors, J. J. Furia, F. L. Bishop.

Donnell, Philip S., Dean of Engineering College, University of New Mexico, Albuquerque, N. M. Sponsors, F. L. Bishop, H. E. Dyche.

Hall, Stanley Gilbert, Instructor, University of Illinois, Urbana, Ill. Sponsors, R. P. Hoelscher, F. M. Porter.

Hall, V. B., Assistant Professor of Physics, Bucknell University, Lewisburg, Pa. Sponsors, D. M. Griffith, F. E. Burpee.

Hansen, Arthur S., Instructor in Mathematics, Armour Inst. of Technology, Chicago, Ill. Sponsors, H. M. Raymond, E. H. Freeman.

Hatfield, Harold D., Dean, College of Applied Science, Howard University, Washington, D. C. Sponsors, W. C. John, F. L. Bishop.

Heck, Chester R., Manager, College Dept., McGraw-Hill Book Co., Inc., New York City, N. Y. Sponsors, W. S. Rodman, G. W. Farnham.

HOMBERGER, ALFRED W., Professor of Chemistry, Director, Chemical Laboratories, University of Louisville, Louisville, Ky. Sponsors, B. M. Brigman, W. B. Wendt.

KEITH, WAYNE E., Director of College Relations, New England Telephone & Telegraph Co., 1230 Montello St. Sponsor, R. I. Rees.

KENNY, FREDERIC J., Professor of Analytical Chemistry, Manhattan College, New York City. Sponsors, J. J. Furia, F. L. Bishop.

KERKES, FRANK, Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa. Sponsors, A. H. Fuller, A. M. Greene.

MARTINSON, EARL P., Assistant Professor of Mathematics, Colorado School of Mines, Golden, Colo. Sponsors, W. J. Risley, M. F. Coolbaugh.

MAYER, JOSEPH, Professor and Head, Dept. of Economics and Sociology, Tufts College, Tufts College, Mass. Sponsors, G. C. Anthony, E. H. Wright.

MERRITT, HAROLD W., Instructor in Physics, Cooper Union Inst. of Technology, New York City, N. Y. Sponsors, F. M. Hartman, F. E. Foss.

MORGAN, JESSE R., Professor of Languages and Economics, Colorado School of Mines, Golden, Colorado. Sponsors, M. F. Coolbaugh, W. J. Risley.

PURDIE, K. S., Assistant Professor of Mathematics, Virginia Military Inst., Lexington, Va. Sponsors, H. P. Hammond, R. B. Poague.

ROBERT E. ROBB, Professor of Civil Engineering, Evansville College, Evansville, Indiana. Sponsor, Max B. Robinson.

SCAMMAN, WILLIAM F., Instructor in English, University of Maine, Orono, Maine. Sponsors, H. M. Ellis, W. E. Barrows.

SMITH, LINCOLN S., Professor of Electrical Engineering, Northeastern University. Sponsors, W. H. Kenerson, S. W. Dudley.

STOUKING, ERNEST J., Assistant Professor of Civil Engineering, University of South Dakota, Vermillion, S. D. Sponsors, M. W. Davidson, L. E. Akeley.

WOOD, A. R., Assistant Professor of Electrical Engineering, Massachusetts Inst. of Technology, Cambridge, Mass. Sponsors, D. C. Jackson, C. V. Bullen.

President Boardman expressed his appreciation of the large gathering which the University of Maine had—this being the largest meeting the Society has ever held. President Leland expressed his appreciation of the honor which the Society had conferred upon him as President and his appreciation of the privilege that he had during the past year of serving the members.

The meeting adjourned *sine die* at 12 M.

SOCIAL FEATURES OF THE ORONO MEETING.

The members and guests who attended the 35th annual meeting of this Society this summer were unanimous in voicing their appreciation of the entertainment—the most outstanding feature of the convention—furnished by our hosts. From the time we were met at the hotel in Burlington, Vermont, on June 24, to the farewell on July 1 when the last member reluctantly turned his footsteps toward home, we were entertained in a most royal manner.

Fourteen machines congregated at the University of Vermont on Friday evening, June 24, and led by Dean J. W. Votey, we motored to the Burlington Country Club, where we were the guests of the University of Vermont at a dinner. This dinner was strictly informal, no speakers, nor anything else to mar our pleasure. We were asked at the conclusion of the dinner to go to Robinson Hall for a social hour. At this time Dean Votey issued instructions as to the trip to the University of Maine beginning the next morning.

Saturday morning found fourteen cars with forty-eight passengers lined up in front of the home of our guide, Dean Votey. Fourteen institutions and eight states were represented in this "caravan." We got off on schedule time and proceeded to the base of Mt. Mansfield, through historic Smugglers' Notch, to St. Johnsbury. We stopped at St. Johnsbury where we were the guests of the Rotary Club of that city at their weekly luncheon. When we entered St. Johnsbury the flags were flying and we found to our great joy and surprise that the Chamber of Commerce had ordered the flags flown in our honor. After lunch we were escorted to the Cary Sugar Company where we, who were not New Englanders, learned for the first time the taste of real maple sugar.

At six o'clock we pulled up to the doors of the Bethel Inn, Bethel, Maine, where everything possible had been done for our comfort. There were no flags flying for us here but we

did find a police escort awaiting us. After spending a very delightful evening with the other members of the party, we were all ready for the final lap to the University of Maine. Early Sunday morning, we fell in line behind our motorcycle escort. The favorite in-a-car sport on this portion of the trip was watching our escort pull up alongside a little machine, ask the driver to pull over to the side of the road and let us pass. A driver of a larger car passed all of us until he reached the first car when he discovered that we had a police escort. His nerve failed him and he fell in line and it was several hours before he could muster enough courage to pull away from us.

We stopped at the Augusta House, Augusta, Maine, for dinner and then proceeded without interruption to the University of Maine, at Orono, where we were met by our genial hosts, the President and the Faculty of the University.

Monday afternoon Mrs. C. B. Gould entertained the ladies with a tea at her home, and in the evening there was dancing for all, with special novelty dances by Shirley Clendenning and pupils, and refreshments.

Tuesday the ladies were entertained at a bridge luncheon at the Penobscot Country Club. In the afternoon we were welcomed by President and Mrs. H. S. Boardman in their home, and in the evening Irving Pierce, tenor soloist, entertained us.

Wednesday morning the ladies had breakfast at "The Elms." Cars were provided, with police escort, and we all motored to Lucerne in Maine for luncheon. This is one of the beauty spots in Maine. In the evening the annual dinner was held in the gymnasium at which time President O. M. Leland gave his presidential address, "Are We Making Progress?" We were honored at this dinner by an informal talk from the Governor of the State of Maine, Ralph O. Brewster. Dancing and refreshments followed.

Thursday the ladies were entertained with an automobile trip along the Penobscot River, with a visit to the Old Town Canoe Company (largest canoe factory in the world); and

with a tea at the home of Mrs. W. J. Sweetser. In the evening we again had moving pictures.

Friday was devoted to a trip either to Moosehead Lake and Kineo or to Bar Harbor, Seal Harbor, Northeast Harbor and other points of interest on Mt. Desert Island.

Many members who left Maine on Thursday visited the Massachusetts Institute of Technology on Friday morning at the invitation of President S. W. Stratton. Visitors met at the Department of Naval Architecture where they were received by a local committee under the chairmanship of Professor C. E. Tucker.

REPORT OF COMMITTEE 22 ON CHEMICAL ENGINEERING.

Committee No. 22 on Chemical Engineering plans to make a further study of the courses in Chemical Engineering as at present conducted in the various colleges in the country with the aim of supplementing the information gathered in the "Investigation of Engineering Education" and published in Bulletin No. 11. That Bulletin states:

"In some cases it was necessary to make certain arbitrary classifications, for example: Chemistry taught in the first two years of the chemical engineering curriculum was classed under physical science and that given in the last two years under the principal branch of engineering."

The Committee feels that further differentiation is desirable and expects to seek additional data during the coming year.

(Signed) A. H. WHITE, *Chairman*,
C. A. MANN,
H. C. BASHIOUM,
R. H. MCKEE,
J. R. WITHROW.

REPORT OF THE COMMITTEE ON ENGLISH.

While the Board of Investigation and Coordination has been making its monumental investigation into the facts of engineering education, the Committee on English has been proceeding with the survey of the status of English in the engineering colleges which had been projected before the organization of the larger research. It was the hope of the Committee that such a survey of its own limited field might put it in a better position to make its contribution to the cause of engineering education when the time came for constructive suggestions. The research of the Committee was planned for a five year period; for with financing to the extent of only thirty dollars or so a year from the Society, the Committee has hardly been able to use even stenographic help, while its members have at the same time been carrying their usual heavy loads of teaching and administrative work. It has thus far made a study of the aims and objectives for English in the engineering curriculum, the cooperative method of teaching English composition, the means and methods of teaching freshman composition, the development of courses in the appreciation of English literature. There remains a year or two of work before the entire survey can be rounded into final shape.

Meanwhile the publication of the Preliminary Report of the Board in January with its amazing evidence of the mounting tide of recognition of the place of English among the fundamentals, presented in a way an emergency. Such a demand seemed imminent for teachers qualified to give the engineering colleges the quantity and quality of English teaching likely to be called for in the reconstructed curricula that the Committee saw its opportunity for a new and immediate service. It must somehow bring the challenge of this situation to the great body of teachers of English, it must inform them of this new development in engineering education, and, if pos-

sible, prepare them to meet it sympathetically and intelligently.

Unfortunately, as the Committee knows from its many contacts with teachers of English throughout the country, there is among them a great reluctance to undertake teaching in the engineering colleges. They are ignorant of the trend of engineering education; they are cynical regarding the capacity and spirit of our engineering students; they question the genuineness of the professed interest of the colleges in English; they fear to be ostracized by their associates and to jeopardize their prospects for professional advancement by committing themselves to work that appears to them so largely practical and ever commercial in its objectives. Such a situation called for prompt and immediate consideration, just as it will also call for patient, persistent effort over a period of years.

The spirited discussion of the Teacher of English in the Engineering College, which occupied the two-hour joint conference of the deans, administrative officers and teachers of English, at the Orono meeting, terminated in a motion which has given the Committee on English that sanction and assurance of official support which it needed in its effort to bring about a better understanding among the teachers who must be depended on to recruit the ranks of our English faculties. That motion assured the teachers of English of due recognition, of fair remuneration, and of favorable working conditions. The Committee is hopeful that with this assurance of cooperation from the deans, it can help develop a professional group who will be willing to commit themselves to the teaching of English to engineers.

The luncheon-conference and the second general conference at Orono were both full of interest and profit. Miss Harbarger presented a brief digest of her survey of Freshman Composition and Professor Clapp spoke briefly on the proposed Language Research Bureau. The general topic which was discussed was, Making English an Integral Part of the Engineering Curriculum. This topic was suggested by

our study of the Report of the Board of Investigation and Coordination. It is clear that here again in working out a vital and integral relation of English to the other elements in the content of the curriculum, the English Committee may find an opportunity for further service to the cause of engineering education. In addition to the formal conferences, the Committee has held a number of informal discussions, met individuals, and met small groups of expert teachers.

As always throughout its many years of work, the Committee desires to assure this Society of its readiness to cooperate whenever and wherever its efforts can be of most use.

SADA HARBARGER,
W. OTTO BIRK,
H. M. ELLIS,
H. C. RICHARDSON,
J. RALEIGH NELSON, *Chairman.*